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EDUCATIONAL RESEARCH

Assessment of self-explaining effect in a large enrolment General Chemistry course

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Abstract Self-explaining refers to the generation of inferences about causal connections between objects and events for one's own consumption. Self-explaining is amongst the practices of science deemed essential for scientific competence; therefore, a valued learning outcome in itself. Nonetheless, generation of authentic explanations is seldom promoted in college science instruction. This work examined the effect of engagement in self-explaining on conceptual understanding of chemistry. Learning and performance tasks were completed individually in the classroom ecology of a large-enrolment General Chemistry course in the US. The study spanned a period of five semesters including pilot-tests and replications. The self-explaining intervention followed a multi-condition comparison design that used performance on a post-test to assess learning. Students were randomly assigned to the following conditions: reviewing a correct explanation, explaining correct or incorrect answers, explaining agreement with answers produced by others, and explaining their own answers. A cohort of students who underwent standard instruction with no intervention and had prepared for formal examination served as reference. The self-explaining cohorts performed better than the reference group, and in one case was the difference statistically significant. Findings suggest that self-explaining activities support students' conceptual understanding at least as much as instruction. This study contributes evidence for the self-explaining effect and the ICAP hypothesis in a discipline where no evidence is available. Furthermore, it adds to the relatively little work in self-explaining that has explored naturalistic learning environments. This work supports the incorporation of self-explaining activities in the repertoire of instructional practices for General Chemistry.

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PALABRAS CLAVE
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Evaluación del efecto de la auto-explicación en un curso de Química General de matrícula masiva

Resumen La auto-explicación se refiere a la generación de inferencias para el consumo propio sobre conexiones causales entre objetos y eventos. La auto-explicación es una de las prácticas de la ciencia que se consideran esenciales para la competencia científica; por tanto, en sí misma es un valioso producto de aprendizaje. Sin embargo, la generación de explicaciones auténticas en la instrucción universitaria de ciencias se promueve muy poco. Este trabajo examinó el efecto que generar auto-explicaciones tiene sobre la comprensión conceptual de la química. El aprendizaje y la ejecución de las tareas fueron completados individualmente en la ecología natural de un salón de clases en un curso masivo de Química General en los EEUU. El estudio se prolongó por cinco semestres incluyendo las pruebas piloto y las réplicas. La intervención de auto-explicación siguió un diseño comparativo de condiciones múltiples que usó un post-test para evaluar el aprendizaje. Los estudiantes fueron asignados aleatoriamente a las siguientes condiciones: revisión de una explicación correcta, explicación de respuestas correctas o incorrectas, explicación de la opinión sobre preguntas producidas por otros, explicación de las respuestas propias. Se usó de referencia un cohorte que recibió instrucción estándar sin intervención y que se había preparado para la examinación formal. Los cohortes de auto-explicación ejecutaron el post-test mejor que el grupo de referencia; en un caso la diferencia fue estadísticamente significativa. Los resultados sugieren que las actividades de auto-explicación apoyan la comprensión conceptual al menos tanto como la instrucción dirigida. Este estudio aporta evidencia para el efecto de auto-explicación y la hipótesis ICAP en una disciplina en que tal evidencia no estaba disponible. Más aún, suma al relativamente poco trabajo en auto-explicación que ha explorado ambientes de aprendizaje en la ecología natural del salón de clases. Este trabajo apoya la incorporación de auto-explicaciones en el repertorio de prácticas de aprendizaje en la enseñanza de Química General.

Introduction

As the volume of material assigned in entry-level college science courses continues to expand and class enrolment increases, the expectation that substantial learning will occur in the confines of the classroom becomes less tenable. Many first-year college students struggle with the expectation that most learning should occur away from instructor supervision (Conley, 2007). Additionally, evidence suggests learning outside the classroom tends to occur when the learners are unaccompanied (Villalta-Cerdas & Sandi-Urena, 2013). Therefore, it is reasonable to promote classroom-learning strategies transferable to *where and how* unsupervised learning occurs. In light of this, we investigate how to foster self-explaining—an individual learning strategy—in the chemistry classroom context (Villalta-Cerdas & Sandi-Urena, 2014). Furthermore, the US National Research Council has identified self-explaining as one of eight practices deemed essential and desirable for scientific competence (National Research Council, 2013). Besides being a valued learning outcome in itself, the ability to generate one's own explanations supports conceptual learning. Generating scientific explanations engages individuals in analysis and reflection of current models and theories, thereby developing their familiarity and proficiency, and influencing conceptual understanding (Taber & Watts, 2000). Science-learning strategies nurture conceptual understanding so learners can gain the knowledge necessary to solve problems effectively and efficiently. Ford and Wargo (2012) postulate understanding a concept in science is both conceptual and epistemic in nature, and this understanding becomes evident in one's ability to use that concept in explanation and argumentation. Thus, it is through the generation of well-grounded explanations that meaningful understanding may be assessed (Talanquer, 2009). Not surprisingly, support for the beneficial role of constructing scientific explanations abounds, especially in the inquiry literature (Ryoo & Linn, 2014). Research has shown that environments that engage students in scientific explanations can enhance their knowledge, epistemic practices, and literacy skills (Ryoo & Linn, 2014). With few exceptions (Obaya Valdivia, 2004), chemistry education research on explanations has centered majorly on the nature of explanations and their descriptions (Stefani & Tsaparlis, 2009; Taber & Watts, 2000; Talanquer, 2009, 2013), often from the perspective of instruction (Talanquer, 2007; Treagust, Chittleborough, & Mamiala, 2003). In this study we explore student engagement in the process of generating authentic explanations, by and for themselves, through a General Chemistry in-class activity, and its impact on conceptual understanding.

Self-explaining

Self-explaining refers to individuals' generation of their own explanations for their own consumption. It is an individual, non-interactive process different from explaining for others,