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A Functional Analogy on Instructor-Learner Interaction and Reversible Work-Meaningful Learning

Ahmet Gürses[1], Elif Sahin[1], T. Barkın Barın[1], Kübra Güneş[1]

[1] Department of Chemistry Education, Ataturk University, Erzurum 25240, Turkey

Correspondence: Ahmet Gürses. Email: ahmetgu@yahoo.com

Abstract
Analogies can be powerful teaching tools because they can make new material intelligible to students by comparing it to material that is already familiar. In assisting students to understand chemistry concepts, teachers occasionally use analogies. These analogies are believed to help the students to structure the new knowledge and they are considered to be especially useful for topics of an abstract or submicroscopic nature. However, analogies have also been identified as a factor in the students' misunderstanding of chemical concepts. By a functional analogical approach constructed onto the two fundamental concepts (learning and the work in thermodynamics) in this study, the presentation of the similarities between the interactive nature of learning and the requirements enabling a mechanical change such as the reversible expansion is aimed.

Keywords: Analogies, Rote learning, Constructivism, Learning theories, Thermodynamics

1. Introduction

Analogical reasoning, the ability to understand phenomena as systems of structured relationships that can be aligned, compared, and mapped together, plays a fundamental role in the technology rich, increasingly globalized educational climate of the 21st century (Richland and Simms 2015). The use of analogies is well linked to science in both historic and contemporary settings. Well renowned theorists such as Maxwell, Rutherford, and Einstein are reported to have used analogical reasoning as a tool to aid problem solving (Curtis and Reigeluth 1984). Further, it has been proposed that analogies are traditionally used both in explaining science and in the processes of science (Thiele and Treagust 1991). Good teachers frequently use analogies to render unfamiliar matters comprehensible to their students (Thagard 1992). Analogies are most often used to help students understand new information in terms of already familiar information and to help them relate that new information to their already existing knowledge structure. It has been argued that knowledge is constructed in the mind of the learner. As they construct knowledge, learners seek to give meaning to the information they are learning, and the comparative nature of analogies promotes such meaningful learning (Orgill and Bodner 2004). Learning is the change that could be achieved by the learners themselves, as depending on the interaction qualifications of the teaching medium in terms of the quality of outcomes (Piaget 1976). All activities formatted by the instructor organized in class for the realization of learning may be defined as a process of teaching, or a course (Cochran-Smith and Lytle

1993). Firstly we'll consider on the validity of the statement which "The learning only depends on changes in the cognitive levels of learners before and after the teaching" from the point of view of thermodynamics. For this purpose, we have developed a functional analogy, which is based on thermodynamics. In this analogical approach, the exciting analogies were established using pairs such as the ideal gas with the instructor/teacher and the learner/student with the reversible or irreversible expansion produced by the pressure change, and the concept of learning with the achieved work. The proposed analogy is thematically illustrated in Fig.1.

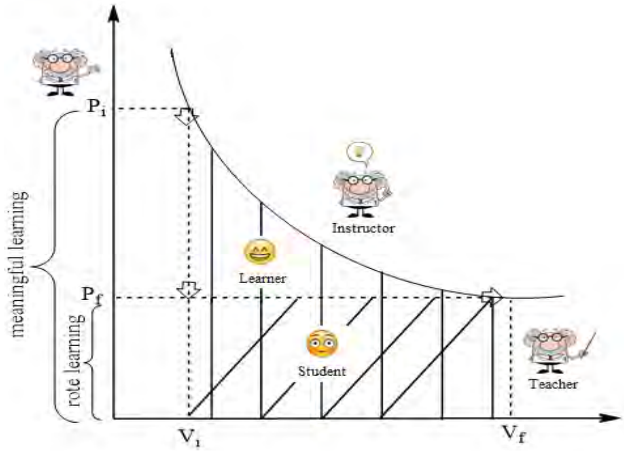

Figure 1: A thematic illustration for the proposed analogy

A reversible change in thermodynamics is a change that can be reversed by an infinitesimal modification of a variable. There is obviously a very close relationship between reversibility and equilibrium: systems at equilibrium are poised to undergo reversible change. Suppose a gas is confined by a piston and that the external pressure is set equal to the pressure of the confined gas. Such a system is in mechanical equilibrium with its surroundings because an infinitesimal change in the external pressure in either direction causes changes in volume in opposite directions. In either case the change is reversible in the thermodynamic sense (Gürses and Ejder-Korucu 2012). If, on the other hand, the external pressure differs measurably from the internal pressure, then change in the external pressure infinitesimally will not decrease it below the pressure of the gas, so it will not change the direction of the process. Such a system is not in mechanical equilibrium with its surroundings and the expansion is thermodynamically irreversible (Atkins and De Paula 1990). To achieve reversible expansion we set the external pressure equal to the internal pressure at each stage of the expansion. Large and small areas under the curve in the p-V diagram depicted in Fig.1 correspond to the reversible and irreversible mechanical work, respectively. In the case of a reversible expansion, the gas particles can be expanded against to a higher pressure at each step of volumetric changes and the process is accomplished over infinitesimal steps. In other words, the more steps and hence more action-reaction equilibrium, the more work. In contrast, in the case of the irreversible expansion, the expansion takes place against to a constant pressure in a single step with a monotonous action-reaction scheme, and the progress of process is controlled by the external pressure.

2. Results and Discussions

The main goal of this analogical approach constructed onto the two fundamental concepts (learning and the work in thermodynamics) is to form awareness on the similarities between the interactive nature of learning and the requirements enabling a mechanical change such as the reversible expansion of a gas. According to the theory of constructivism describing how learning happens, which is generally attributed to Jean Piaget, learner constructs new knowledge from their experiences through processes such as accommodation and assimilation. The learning environment should also be designed to support the learner's inductive thinking skills and enable a more effective instructor-learner interaction (Rosenshine and Stevens 1986). The critical goal is to achieve meaningful learning by supporting the learner in becoming an effective thinker. This can be achieved by ascribing multiple mutual roles for instructor and learner. So now we can claim the existence of a logical relationship between the predicted requirements of this theory regarding the roles of the instructor and learner, and their mutual interaction in the context of meaningful learning or conceptualization and the requirements that enable the reversible expansion of a gas. As will be known, behavioral learning perspective is focused on behavior changes which have been shaped using external reinforcement, where the desired behavior is rewarded and undesirable behavior is punished. The classical conditioning as the important behavioral analytic process used by the behaviorists reveals a behavior acquiring mechanism based on natural reflex by ignoring mental or other internal processes. The behavioral practices in the classroom give teachers the opportunity to control mentally and physically their students, where the educator as a teacher presents the learning content using the deductive approach with the extremely weak mutual interaction, in the meantime, students also are a part of the process as a typical listener. In such a process that will probably provide the rote learning outcomes; the significant similarities between teacher, students, and resulting change and gas compressed (external pressure), expanding gas particles, and irreversible expansion in single step (work) may be noticed.

3. Conclusion

According to this, we can say that an instructional activity should be assessed as a continuous and interactive process that determines the achievement of the learner, the quality of the learning experience and courseware. Therefore, teaching should be considered as the two-way interactive process based on the interactions between instructor and learner. Especially, instruction termed teaching activities cannot be certainly evaluated as the process executed by one person, such as an instructor. So, by approaching from thermodynamic perspective to learning, it can be realized the exciting operational similarity between the learning as a mental change and the mechanical work as a path-dependent change. In other words, the quality of cognitive construction or mental change that occurred after any teaching process cannot be only evaluated by considering of the quality differences between the initial and final learning outcomes. As a result, this analogical assessment has provided a new thermodynamic support to favor the implementations involving constructivist learning approach and active learning to the all teaching activities.

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