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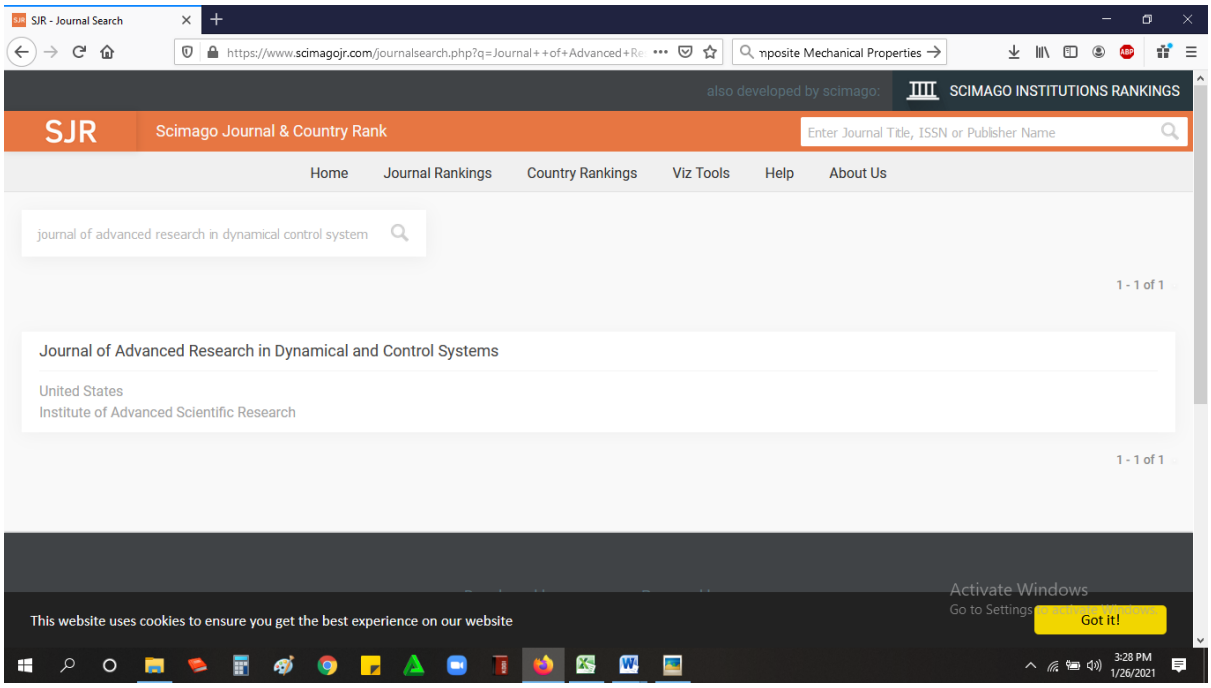

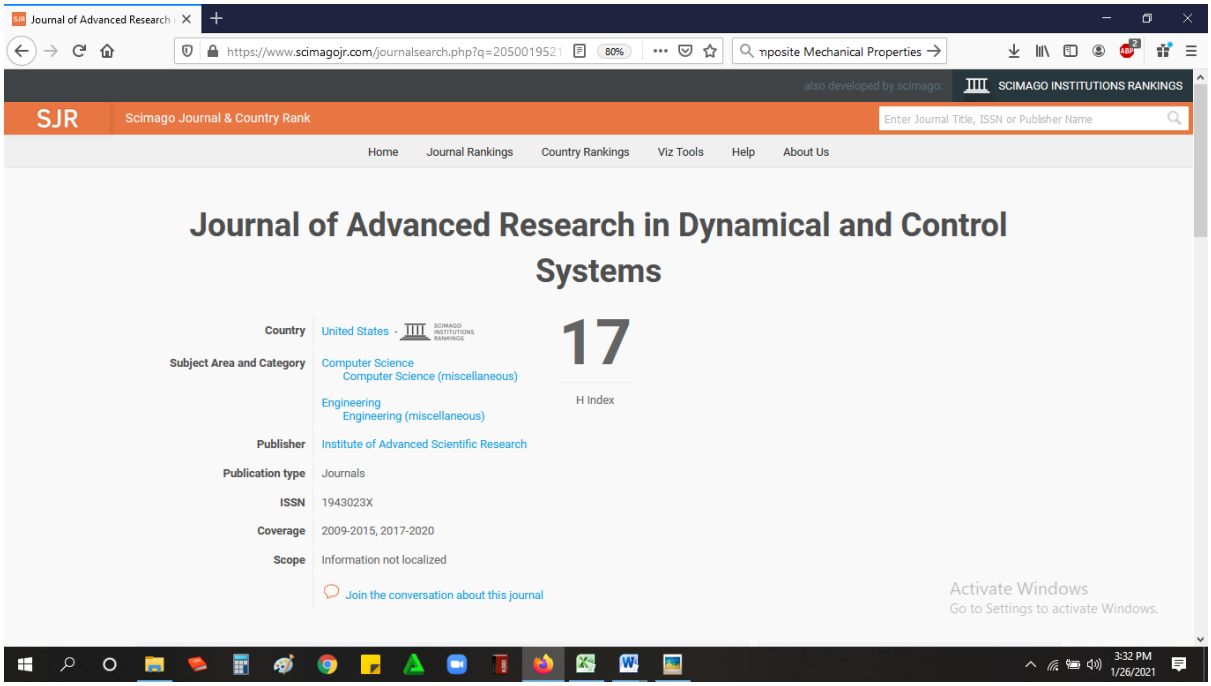

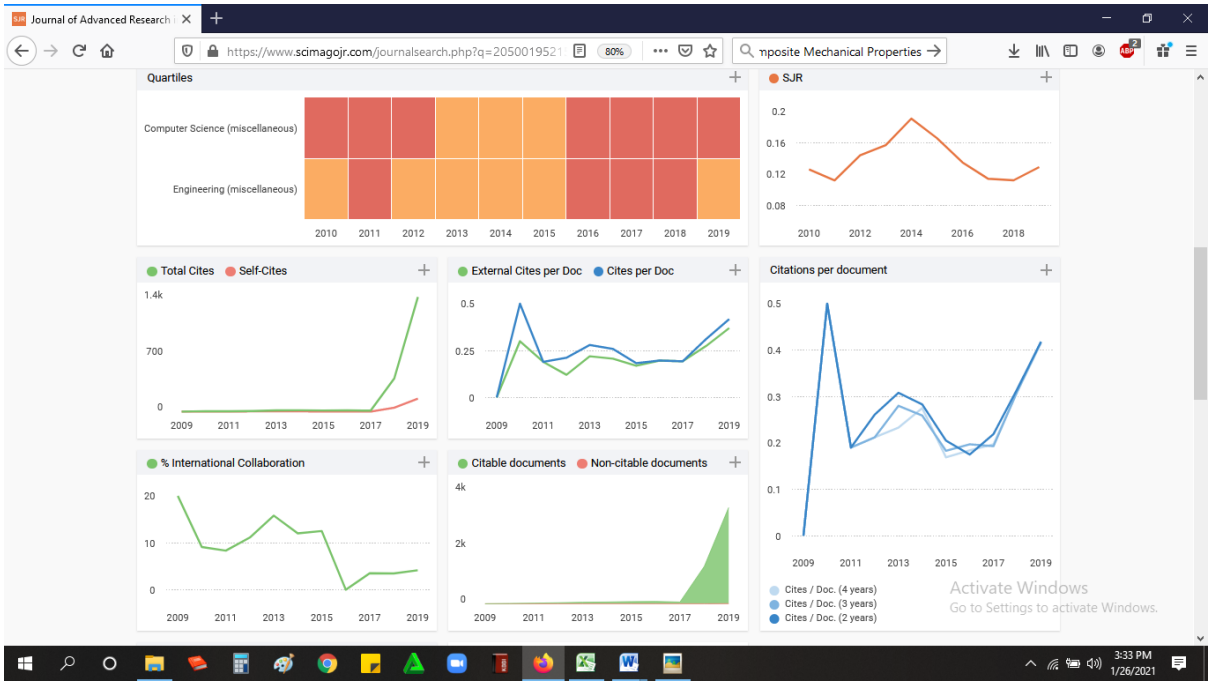
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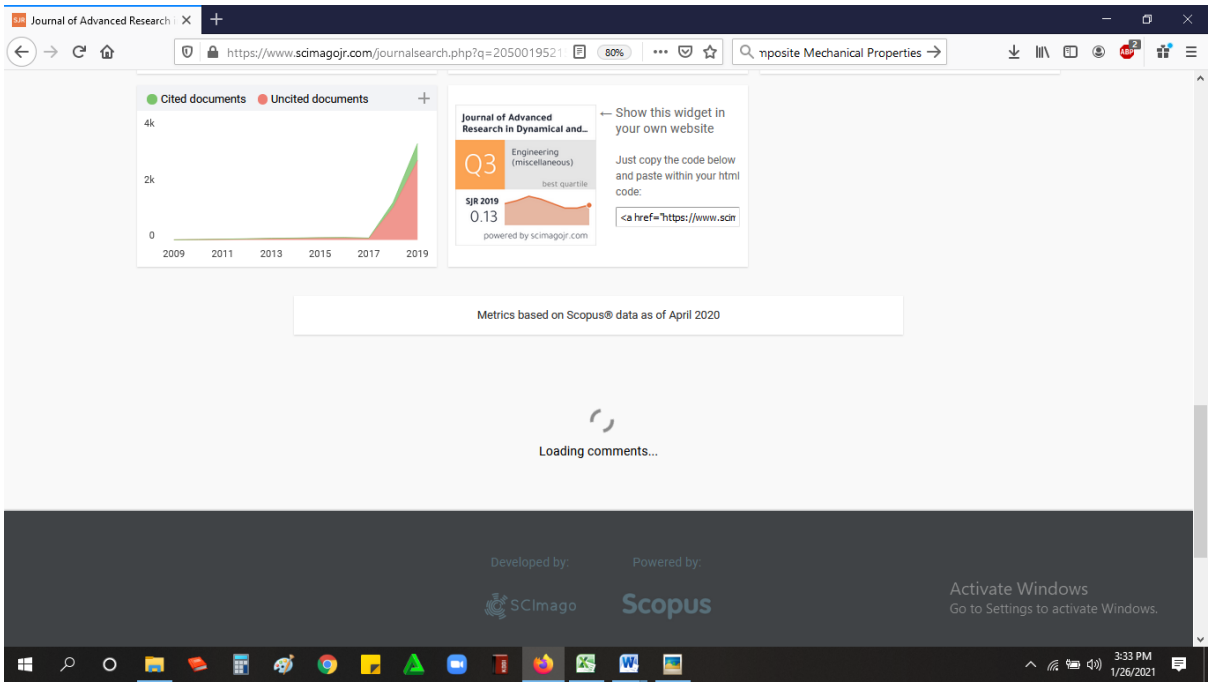
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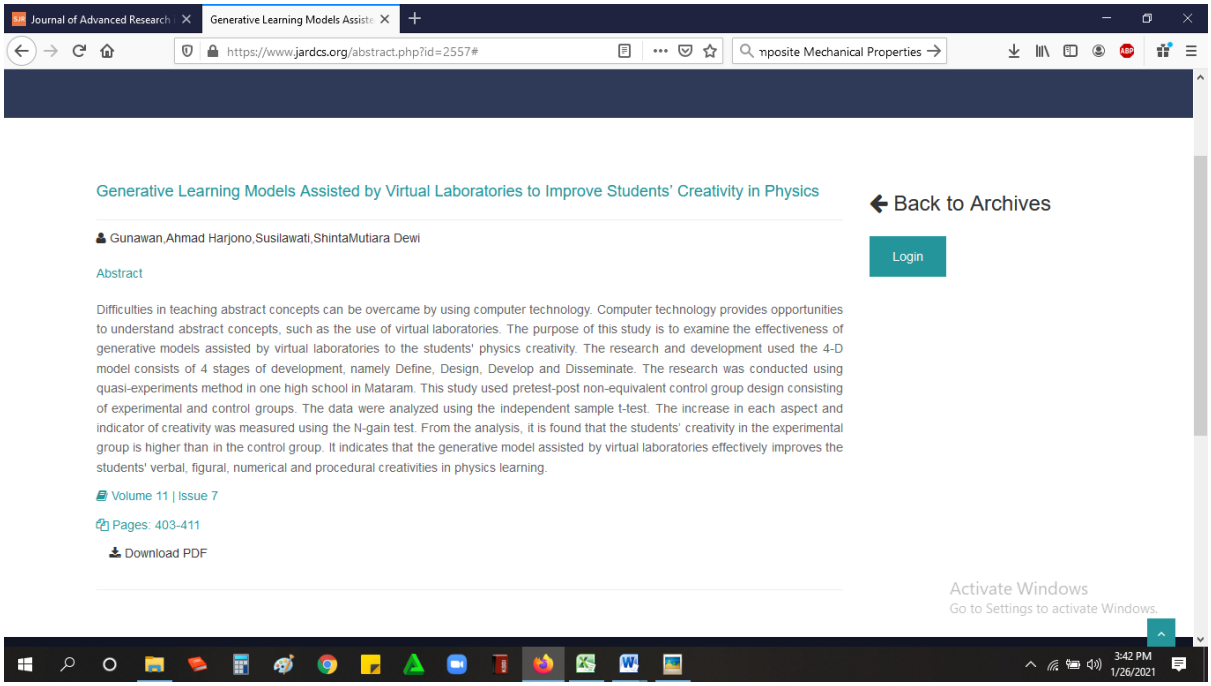

Generative Learning Models Assisted by Virtual Laboratories to Improve Students' Creativity in Physics

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Abstract: Difficulties in teaching abstract concepts can be overcame by using computer technology. Computer technology provides opportunities to understand abstract concepts, such as the use of virtual laboratories. The purpose of this study is to examine the effectiveness of generative models assisted by virtual laboratories to the students' physics creativity. The research and development used the 4-D model consists of 4 stages of development, namely Define, Design, Develop and Disseminate. The research was conducted using quasi-experiments method in one high school in Mataram. This study used pretest-post non-equivalent control group design consisting of experimental and control groups. The data were analyzed using the independent sample t-test. The increase in each aspect and indicator of creativity was measured using the *N*-gain test. From the analysis, it is found that the students' creativity in the experimental group is higher than in the control group. It indicates that the generative model assisted by virtual laboratories effectively improves the students' verbal, figural, numerical and procedural creativities in physics learning.

Keywords: creativity, virtual laboratories, generative models, physics learning

Introduction

Physics learning can train students to develop higher-order thinking skills. One part of higher order thinking skills is creative thinking skills. Creative thinking skills must be developed as an implementation of the curriculum applied in schools (Shaheen, 2010). Thinking is described in terms of chains of implicit symbolic transformational responses (Berlyne, 1965). Students who have good thinking skills will have good responses. Creativity is very dependent on the speed of students in responding to an idea. Students with better thinking skills, they will generate ideas and execute those ideas more effectively (better responses). The development of better thinking skills that will greatly affect the quality of creativity and better creativity is a high level achievement (Gunawan et al, 2018). To achieve these goals, experimental activities is recommended by the number of researches (Lian, Kristiawan, &Fitriya, 2018; Bloom & Dole, 2018).

The alternative to conduct a creative learning environment for physics is by implementing a generative learning model.Generative learning model is a model that can train students in conducting exploration activities to obtain new concepts through the initial knowledge they have with the stages of preparation, focusing, challenges and applications (Anderman, 2010). Teachers can improve students' abilities to remember and connect new ideas through generative strategy designs (Basaffar, 2017). According to generative learning theory, meaningful learning occurs when learners engage in appropriate cognitive processing during learning, including selecting (i.e., paying attention to relevant incoming information), organizing (i.e., mentally arranging the information into a coherent structure), and integrating (i.e., connecting the verbal and pictorial representations with each other and with relevant

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