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The effect of online argumentation upon students' pseudoscientific beliefs

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ABSTRACT

This study investigated how the students' pseudoscientific beliefs could be lessened by using online argumentation. With the aid of an online argumentation system for argumentation instruction and activities for students during the experiment, 77 Taiwanese university students together with 71 Taiwanese high school students (148 students in total) took part in this study. A quasi-experimental design was adopted and quantitative analyses were conducted. The results showed that using an online argumentation system for argumentation instruction and activities could lessen students' pseudoscientific beliefs. The experimental group students were lower than their counterparts in terms of mean pseudoscientific beliefs in the post-test and delayed test. After the experimental group students went through the online argumentation, changes in the percentage of students believing in four out of ten pseudoscientific items reached significance. However, as pseudoscientific beliefs are dependent on the cultural background, generalization of the results in this present study may be limited by cultural context. Finally, this study proposed suggestions related to argumentation research and science instruction counteracting students' pseudoscientific beliefs.

1. Introduction

In agreement with the relationship between individual's pseudoscientific beliefs and the judgment of demarcation of science (Afonsoa & Gilbert, 2010; Turgut, 2011), science educators are expressing increasing concern regarding students' pseudoscientific beliefs (Shein, Li, & Huang, 2014; Tsai, Shien, et al., 2012; Tseng, Tsai, Shieh, Hung, & Huang, 2014). The National Science Foundation in the US has also been conducting long-term studies on the public acceptance of pseudoscience (National Science Board, 2006, 2012). Claims that declare themselves as scientific but are unable to test reliably for their own validity are commonly seen as pseudoscience (Finn, Bothe, & Bramlett, 2005), such as extrasensory perception (ESP). A study conducted by Francis and Williams (2009) found that in the UK, 31% of teenagers believed that it is possible to contact the spirits of the dead. In addition, they found that young believers in this idea and other forms of pseudoscience tended to display lower psychological wellbeing, such as higher anxiety, greater isolation, greater alienation, less positive social attitudes, and less socially conforming lifestyles.

Superstitions and illogical behaviors seem to be common in Taiwan (Chin, 2007), and these pseudoscientific beliefs are related to television exposure which included science-fiction, fortune-telling, and alternative therapy (Tsai, Shien, et al., 2012; Tseng et al., 2014). The culture of pseudoscience has infiltrated society through the media (Preece & Baxter, 2000) and is posing a challenge to science and the teaching of science insofar as it disguises itself as a form of science. As an excess of these pseudoscience programs flood the media, the general public easily gets these mixed up with science, which in turn increases the occurrence of related frauds in society. Moreover, the spread of pseudoscience may further affect the medical attitudes of people, endangering their health (Tsai, Shien, et al., 2012; Tseng et al., 2014). For example, some people in Taiwan may be misguided into believing in “miracle cures” for any chronic diseases they may have for which they have missed their most optimal treatment opportunities, a fact that may worsen their conditions.

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There are several studies that have addressed the phenomenon of young adults believing in pseudoscience that have provided insights into the cultural backgrounds of different countries since the 2000s. For instance, in the 2010 General Social Survey, the youngest age group (18–24) in the US was less likely to say astrology is "not at all scientific" (46%) and more likely to say it is "very" or "sort of scientific" (54%) (National Science Board, 2012). An investigation on university students with mean age 22.2 years in the UK conducted by Rogers, Davis, and Fisk (2009) found that 49% of participants were paranormal believers. In Taiwan, such beliefs are no exception. An investigation conducted by Tsai et al. (2012) on Taiwanese citizens found that the younger they are, the stronger their pseudoscientific beliefs. For instance, 29.9% of citizens between the ages of 18 and 29 believed in divination or fortune-telling, while only 15.4% of citizens between the ages of 50 and 59 did; 39.1% of citizens between the ages of 18 and 29 believed that crystals had the ability to improve their health, while only 22.5% of citizens between the ages of 50 and 59 did. Shein et al. (2014) also found that adults in Taiwan aged 18–29 years held more belief in fortune-telling than those aged 50–65 years. The prevalence of these pseudoscientific beliefs across multiple cultures suggests that there may be developmental and cultural aspects to these beliefs. Tsai et al. (2012) pointed out that the causes of pseudoscientific beliefs vary; they may be a result of media exposure, social motives, religious traditions, or 'confirmation bias', the tendency of observers to see what they expect to see when making observations.

The aforementioned results showed that some young Taiwanese citizens and students tend to believe in pseudoscience. Therefore there is a need to gain a better understanding of this situation and suggest any necessary measures to counteract it. Some researchers (Afonsoa & Gilbert, 2010; Losh & Nzekwe, 2011; Tseng et al., 2014; Wang, Lin, & Chang, 2011) reserved their opinions regarding whether science instruction may help lower pseudoscientific beliefs as they posited that current science instruction efforts have not developed any related courses or instruction strategies to train students in differentiating pseudoscientific contents. Related researchers (Lundström, 2007; Tseng et al., 2014) posited that in order to lower the rates of pseudoscientific beliefs, students may be trained in terms of their ability to engage in evidence-based reasoning and their skills in performing scientific processes, and that these forms of knowledge may be instilled through argumentation.

Argumentation has played a vital role in the decisions made throughout the development of any form of scientific knowledge (Driver, Newton, & Osborne, 2000). Students may get to know more about the argumentation process involved in the scientific practices in their society and culture through explorative activities during lessons, deepening their understanding of the meaning of science. In the process of a reflective online asynchronous argumentation, students take turns and are assigned roles to actively construct, discuss, and debate arguments online using text-based communication tools (Lin, Hong, & Lawrenz, 2012). The Internet has been thus believed as an effective tool for conducting argumentation instruction and activities (Bell & Linn, 2000; Choi, Hand, & Norton-Meier, 2014; Clark & Sampson, 2008; Lu & Zhang, 2013; Noroozi, Weinberger, Biemans, Mulder, & Chizari, 2013; Yeh & She, 2010; Yu & Yore, 2013). Moreover, the current generation of students is quite familiar with the use of social media. Therefore, with argumentation and Internet tools serving as the instruction strategy, this study investigated the relationship between online argumentation and students' pseudoscientific beliefs. It is hoped that the data from this study may be used as a source of reference for future science education studies.

1.1. Pseudoscientific beliefs

Pseudoscience is a claim or practice which presents itself as a form of science, but lacks the valid scientific method in the explanation to the scientific community for the validity of its claims or theories (Afonsoa & Glbert, 2010; Bunge, 2011; Preece & Baxter, 2000; Shermer, 1997). Scientific knowledge calls for a set of methods designed to describe and interpret observed and inferred phenomena, past or present, and aimed at building a testable body of knowledge open to rejection or confirmation (Shermer, 1997). Scientific theories which are widely accepted by the current scientific community must be verified under a fixed structure, including verification of the theory itself and also the justification of the research methods used throughout the process (Lakatos, 1970). Therefore, when a claim brands itself as science yet fails to meet the norms of scientific research approved by the scientific community, it is viewed as pseudoscience. As such, pseudoscience usually has a trait of disguising itself as a form of science that is not easily distinguishable from actual science.

Paranormal claims are also considered a form of pseudoscience that plants its arguments outside the range of scientific explanation (Eder, Turic, Milasowszky, Van Adzin, & Hergovich, 2011). Such claims are also described as having explanations beyond the capability of mainstream science. If these are real, it goes against the principle limitations of basic science. Therefore paranormal claims, being unable to be affirmed by the scientific community, are classified as a form of pseudoscience. Claims for paranormal phenomena exhibit the traits of pseudoscience, such as the lack of testability and falsifiability, and being dependent on only selective evidence (Allchin, 2004; Finn et al., 2005).

In terms of the concrete proposal of the topic of pseudoscientific beliefs, Tobacyk and Milford (1983) specifically developed a widely used "Paranormal Beliefs Scale" which consists of 26 items, such as aliens, ESP, and telekinesis. The National Science Foundation has also picked the most commonly pseudoscience behaviors among citizens, including astrology, lucky numbers, UFOs, ESP, and magnetic therapy (National Science Board, 2006). According to a Gallup poll, the most widely believed in paranormal phenomena throughout history include ESP, ghosts, telekinesis, clairvoyance, and astrology (Moore, 2005). Combining all the above scales, Tseng, Tsai, Hung, Liu, and Huang (2008) used means of exploratory factor analysis and divided pseudoscientific beliefs into: beliefs in fortune-telling, beliefs in health practices, and beliefs in the paranormal (Tsai, Shien, et al., 2012; Tseng et al., 2014).

1.2. Argumentation and online argumentation

Argumentation is often defined as a process of coordination of claims and data through justification and negotiation which focus on mutually acceptable explanations (Clark & Sampson, 2009; Jimenez-Aleixandre & Erduran, 2008; Kuhn, 2005; Osborne, Erduran, & Simon, 2004; Yu & Yore, 2013). Arguments are the artifacts of argumentation and consist of conclusions, supporting data, or reasons (Zohar & Nemet, 2002). The difference between "argumentation" and "argument" is that the former represents the entire debate process; the latter represents the decisive and explanatory contents during the debate process (Osborne et al., 2004; Sampson & Clark, 2008; Yu & Yore, 2013). Argumentation thus consists of both social and individual meanings (Jimenez-Aleixandre & Erduran, 2008; McNeill & Krajcik, 2009). Toulmin (1958) proposed a theoretical model (the Toulmin's Argument Pattern, TAP) that has had a profound impact on the argumentation