An Exploratory Look into the Temporal Aspects of Productive Versus Hopeless Confusion

Jeremiah Sullins[1], Daniel Neely[1], Tim Davis[1], Samuel Acuff[2]
[1]Harding University [2]University of Memphis

Abstract

Recent research has shown an inexplicable link between emotions and learning. In this study we focused on the emotion of confusion. More specifically, this study examined the role of productive confusion versus hopeless confusion in learning. The goal was to gain a better understanding of the circumstances that differentiate these two different types of confusion. Results revealed a significant difference in the time of confusion resolution between learners with high and low mental model shifts. Furthermore, a significant difference was found regarding the occurrences of confusion between high and low mental model shifters throughout the learning session. We identify implications and applications.

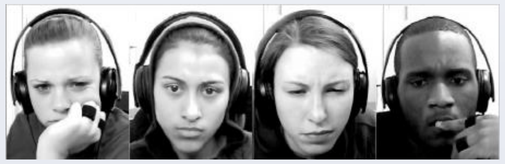

Figure 1. Examples of confused faces from participants

Introduction

Recent research has discovered that not only are emotions present during learning, certain emotions are inextricably linked to learning. In fact, the 21st century has been ripe with empirical evidence exploring links between emotions and cognition (D'Mello & Millis, 2014; D'Mello, Lehman, Pekrun, & Graesser, 2014; Lehman et al., 2013). The focus of this proposal is on one specific learning-centered emotion: confusion. The reason that we are focusing on confusion is because research has suggested that confusion is both prevalent in and important to learning (Baker et al., 2010; Craig et al., 2004; D'Mello & Graesser, 2011; Graesser, Chipman et al., 2007; Rodrigo & Baker, 2011a; Lehman et al., 2008; D'Mello, Lehman, & Person, 2010; VanLehn, Siler, Murray, Yamauchi, & Baggett, 2003). The relationship between confusion and learning is consistent with several theories that highlight the merit of impasses during learning (Brown & VanLehn, 1980; VanLehn et al. 2003) and with theories that claim that cognitive disequilibrium is one precursor to deep learning (Graesser & Olde, 2003). According to these theories, confusion is triggered when learners are confronted with information that is inconsistent with existing knowledge and learners are unsure about how to proceed. These events that trigger impasses place learners in a state of cognitive disequilibrium, which is ostensibly associated with heightened physiological arousal and more intense thought as learners attempt to resolve impasses.

Hopeless vs. Productive Confusion

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Although the findings are still equivocal, there does seem to be a common theme emerging. Inducing a state of confusion in a learner only produces superficial learning gains in a large amount of cases. This superficial learning can be compared to Piaget's beta level of adaptive responses in which learners only show partial modification of their understanding of a particular topic. One possible explanation for this lack of deep conceptual change could be due to the fact that the confusion that learners experience during these various learning tasks is never fully resolved. This unresolved confusion could lead to a state of hopeless confusion (as opposed to productive confusion) which results in an unsuccessful cycle of frustration and boredom.

Hopeless vs. Productive Confusion (cont.)

Studies suggest that hopeless confusion can lead to a student getting "trapped" in the negative affect cycle of frustration and boredom. More specifically, if students are unable to work through their confusion, they are likely to give incorrect responses to questions which eventually can lead to the student giving up or attempting to "game the system" when possible.

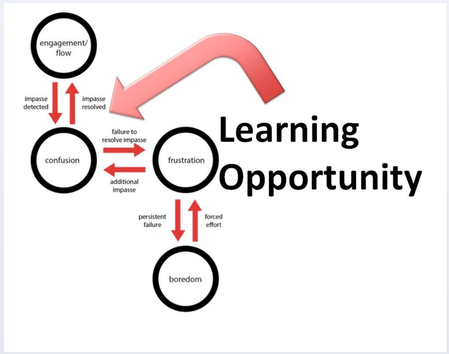


Figure 2. Model of vicious and virtuous cycles

Methods and Procedures

Participants completed:

- Labeling pretest- labeled different components of the circulatory system on an illustration of the heart
- Matching pretest- matched functions of the circulatory system with key terms
- Essay pretest- write down everything they could about the circulatory system

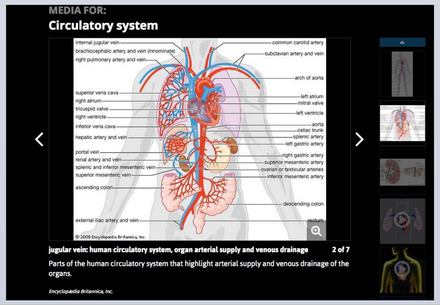
Participants were then shown the home page of Encyclopedia Britannica and told that they were being presented with a hypermedia encyclopedia and their job is to learn all they can about the circulatory system in 40 minutes. Participants were told that they would be asked to "emote-aloud": 1) their level of confusion on a scale from 1 to 10 and 2) their belief that they could work through their confusion.

Following their interaction with the hypermedia learning environment, participants completed:

- Posttests (counterbalanced with the pretests; labeling, matching, essay)
- Achievement Emotions Questionnaire (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011)

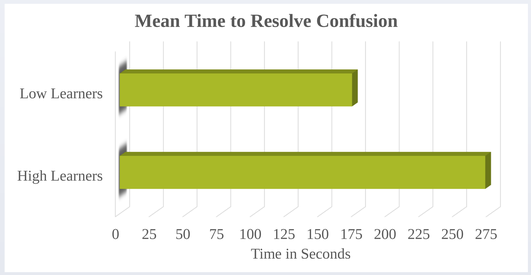
Hypermedia Learning Environment

A hypermedia environment is a nonlinear medium of information which includes graphics, audio, video, plain text and hyperlinks. The hypermedia learning environment used in the current study was Encyclopedia Britannica.

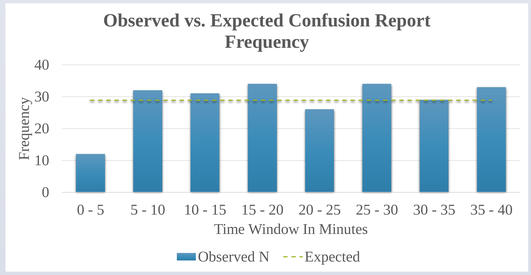


Results

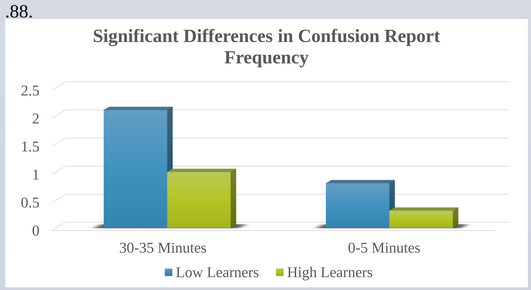
In comparing the data between participants who had high mental model shifts versus low mental models shifts (as measured by post-pre essay scores), results revealed a significant difference in the amount of time spent in order to "resolve" confusion, t (23) = 2.301, $p < .05$, d = 1.28. More specifically, high mental model shifters spend significantly more time resolving each instance of confusion (M = 271.20 seconds) compared to the low mental model shifters (M = 172.44 seconds).



In order to determine the frequency of confusion across the 40 minutes, each participant's learning session was broken into five minute intervals (i.e., eight intervals). A chi square goodness of fit was performed on the observed versus expected amount of confusion during each interval. Results revealed a marginal significance, χ^2 (7, N = 23) = 13.05, p = .07. Further examination revealed that there were substantially fewer instances of confusion during the first five minutes (12) than would have been expected (28.9).



Results revealed a marginally significant difference in the amount of confusion reported between low mental model shifters (M = .80) and high mental model shifters (M = .31) during the first five minutes t (21) = 1.854, p = .07, d = .78. Additionally, a significant difference was discovered in the amount of confusion reported between low mental model shifters (M = 2.1) and high mental models shifters (M = 1.0) during the 30-35 minute portion of the encyclopedia interaction, t (21) = 2.089, p = .049, d = .88.



Conclusions

The results from the current study have exciting implication. Up to this point it has been shown that confusion is positively correlated with learning gains. However, simply placing a student in a state of confusion is not enough by itself to produce learning. As mentioned previously, if a student experiences repeated failures and is stuck, they may transition into a cycle of frustration and boredom. Conflict resolution seems to be a key component that requires students to stop, think, effortfully deliberate, problem solve, and revise their existing mental models. The question up to this point has been how long do you leave a learner in a state of confusion in order for the confusion to be beneficial? The results from the current study provide a starting point that suggests an optimal time frame for confusion to remain productive (~5 minutes).

The results from the aforementioned study has the potential to impact several different audiences. For example, educators (e.g., state and local school system administrators, principals and teachers) will be able to immediately implement the methodologies investigated in these studies. Imagine a student that has enrolled in an online course. Typically these courses consist of reading from textbooks and writing papers. However, based on these results, educators could simply insert confusion inducing scenarios for a predetermined time into the curriculum which in turn could lead to higher learning gains. This same principle could be applied to traditional education at all levels (elementary through college). Instead of delivering traditional lecture based information, teachers will be able to effectively induce and resolve confusion at the appropriate times which in turn would be beneficial for learning.

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Contact Information

Jeremiah Sullins, Ph.D.
Assistant Professor of Psychology
Harding University
915 E. Market Ave.
Box 12260
Searcy, AR 72149

Personal Website: http://sites.google.com/site/jeremiahsullins

S.A.I.L. Lab Website: https://sites.google.com/site/hardingsaillab/