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.

Introduction
Recent research has discovered that not only are emotions present during learning, certain emotions are intrinsically linked to learning. In fact, the 21st century has been ripe with empirical evidence exploring links between emotions and cognition (D’Mello & Millar, 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; Rodrigio & 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 & Campione, 2003). The relationship between confusion and learning is consistent with several theories that highlight the merit of impasses during learning (Brown & Campione, 2003). The relationship between confusion and learning is consistent with several theories that highlight the merit of impasses during learning (Brown & Campione, 2003).

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: wrote down everything they could about the circulatory system.

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, f(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).

Conclusions
The results from the current study have exciting implication. Up to this point it has been shown that confusion is inversely 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 do you have 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 benefit for learning.

References
An Exploratory Look into the Temporal Aspects of Productive Versus Hopeless Confusion
Jeremiah Sullins1, Daniel Neely1, Tim Davis1, Samuel Acuff2
1Harding University 2University of Memphis

Figure 1. Examples of confused faces from participants

Figure 2. Model of vicious and virtuous cycles

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.

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: wrote down everything they could about the circulatory system.

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, f(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).

Conclusions
The results from the current study have exciting implication. Up to this point it has been shown that confusion is inversely 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 do you have 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 benefit for learning.

References

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