Identifying Methods to Induce Productive Confusion for Improving Performance in Physics

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Abstract: A gap currently exists in the literature regarding how to most effectively harness the power of confusion in learning. In order to address this gap, the present study sought to explore which methods of confusion induction are most beneficial for deep learning. Results revealed that Breakdown Scenarios were the most effective confusion induction technique compared to a lecture-based format. Additionally, significant interactions were discovered between Breakdown Scenarios and certain individual difference measures.

Introduction

The current study sought to demonstrate the most effective ways to induce the impasses that lead to productive confusion which in turn result in significant learning gains. The reason that we focused on confusion is because research has suggested that confusion is both prevalent in and important to learning (Craig et al., 2004; D'Mello & Graesser, 2011; D'Mello, Lehman, Pekrun & Graesser, 2014). 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.

Procedures

Following the informed consent, participants completed the following tests: Achievement Goal Questionnaire and the Attributional Complexity Scale. After the completion of the tests of individual differences, participants completed the pretest (counterbalanced with the posttest). Because the study was a laboratory-based randomized experimental trial, participants were randomly assignment to one of **four levels** of our independent variable (i.e., induction of desirable confusion): **1) Breakdown Scenarios 2) Deep Questions 3) Intra-testing, and 4) Control** to determine impact on students' learning. In all sessions, participants watched pre-recorded "tutoring/content delivery". Physics was the content domain used in all conditions. The physics content scripts were developed by a physics professor at the university where the research was conducted. In the Breakdown Scenario condition, participants were presented a scenario that does not work as expected. The participants were then asked to explain the rationale (i.e., the physics principle) for why the scenario was not working. In the Deep Questions condition, participants were given questions that could only be answered by having a conceptual understanding of the material being covered. The questions were classified as deep according to an existing question taxonomy (Graesser & Person, 1994). The Intra-testing condition required students to complete a mathematically based physics problem. The control condition was an information delivery of the content.

Results

Initial data analysis revealed the largest differences between the Breakdown Scenarios condition and the Control condition. Because of this, Deep Questions and Intra-testing were removed from subsequent analyses. Results revealed that participants in the Breakdown Scenarios (M = 2.55) learned significantly more from pretest to posttest compared to participants in the Control condition (M = .83), t (55) = 2.316, p = .024, d = .63. Additionally, a significant pairwise comparison was discovered between Condition and Attributional Complexity. More specifically, participants with high Attributional Complexity in the Breakdown condition (M = 3.00) had significantly higher pretest to posttest change scores compared to those with high attributional complexity in the Control condition (M = .941), p = .03. Results revealed multiple significant pairwise comparisons between Condition and Goal Orientation. Participants in the Breakdown Scenario with Performance Approach Goal Orientation (M = 4.60) learned significant more than participants in the Control with Performance Approach Goal Orientation (M = .917), p = .019.

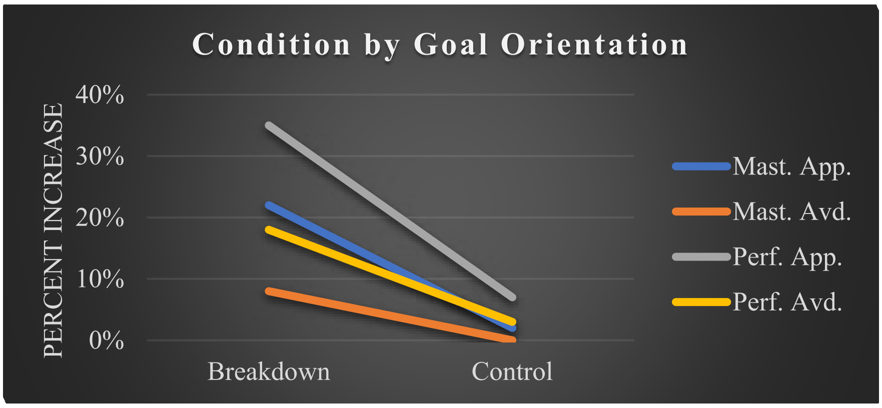

Figure 1. Learning gains for condition by goal orientation interaction.

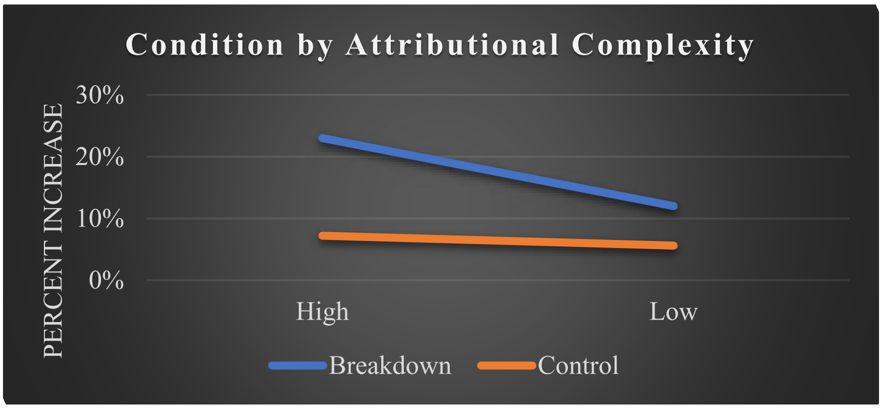

Figure 2. Learning gains for the condition by attributional complexity interaction.

Scholarly significance

Adding to the body of research on emotions and learning, results suggest that *Breakdown Scenarios* were the most effective method to induce an impasse which in turn led to the highest learning gains compared to lecture based information delivery. It is the opinion of the authors that the reason for the lack of significant learning taking place in the remaining conditions was due to the presence of frustration or hopeless confusion rather than a state of productive confusion. Frustration occurs when an individual experiences repeated failures and is stuck. Persistent (or hopeless) confusion occurs when conflict resolution fails and an individual is unable to restore equilibrium. The learners in the *Breakdown Scenarios* were most likely to engage in conflict resolution given the nature of the different interventions. This conflict resolution required the learners in the *Breakdown Scenarios* to stop, think, effortfully deliberate, problem solve, and revise their existing mental models which in turn led to a deeper understanding and retention of the physics content being delivered. Educators need to think about confusion in learning as an elastic slingshot. It has the potential to propel some learners into higher altitudes of understanding. However, pull too tight and the elastic breaks resulting in negligible or negative learning gains.

References

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