How People Learn: Articles Analyses[1]

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In this paper, I analyze two recent articles, [1] and [2], which deal with the cognitive development of college students and the biology of learning, respectively.

In **[1]**, the authors' main goal was to explore the interrelatedness between student-faculty interaction, classroom engagement, and cognitive skills development in students. They based their study on data collected from surveying 5,169 senior University of California students, across 10 campuses. They found that student-faculty interactions fosters a greater sense of belonging among the students, and also improves their cognitive skills. In **[2]**, the authors review studies in educational neuroscience on conceptual change, an aspect of learning that involves more complex learning mechanisms, involving a different set of components of the brain, rather than what is typically involved in learning that is more direct, for instance, learning facts.[2] With the advances in neuroscience, different parts of the brain have been attributed to various memory functions: visuospatial processing, visual attention, conflict monitoring, etc. Thus, knowing which brain components are involved in conceptual change learning can help educational psychologists gain insight into improving learning that involves conceptual change, which is the main goal of the authors.

In the rest of this paper, I further discuss key findings from these papers, and propose how ideas presented in the papers may be used integratedly to advance learning practices.

Let us first explore conceptual change, the main theme explored in **[2]**. In a nutshell, it is the changing of one's ideas. In the space of cognitive science, it is a cognitive process involved in more complicated forms of learning, which involves learning new information, reconsidering and updating knowledge that has been already learned, and altering different pieces of related information. Such learning is typically involved in science learning. Unlike cognitive processes involved in more direct forms of learning, such as the acquisition of procedural knowledge (tacit rules, habits, etc.) and declarative knowledge (descriptive facts, dates, etc.), conceptual change can be complex because it deals with conceptual knowledge. The case of understanding the common flu may be used to understand these three categories of knowledge, as illustrated in [2]: knowledge of covering one's mouth while coughing is procedural knowledge, knowledge of viruses' ability to cause cold is declarative knowledge, and finally knowledge of viruses' ability to spread via coughing is conceptual knowledge.

Conceptual change is an important cognitive process because it helps in clearing out misconceptions, a popular activity in science learning. Moreover, due to the highly interrelated nature of conceptual knowledge, it has been found that conceptual change is difficult to change (In [2]: Dole & Sinatra, 1998; Nadelson et al. 2018). While many previous studies have identified several learning activities that promote conceptual change (e.g. participation in scientific investigations, reading refutation texts, and activating background knowledge), Vaughn et al. [2] study neuroscientific approaches that, assisted by modern brain imaging equipment, investigate brain regions and networks involved in science learning and knowledge revision. This is a novel and important approach towards *the study of conceptual change* in the field of educational psychology as it allows practitioners to focus on specific functions, well known to be attributed to certain brain regions, towards the goal of ameliorating conceptual change learning.

An interesting finding surveyed in [2] is that of Masson et al. (see Masson et al. 2014 in [2]). In this study, fMRI was used to compare brain activity between two groups of participants in evaluating the correctness

[2] This crucial nuance between conceptual change learning and direct learning is discussed shortly afterwards.

of electrical circuits. One group was a group of experts, and the other was a group of novices. From brain imaging data, and the responses, the authors found that misconceptions may be retained even in experts, and for them to give correct answers, the misconceptions must be suppressed in their memory. This was evidenced by an increase in the experts' brain activity in the areas associated with inhibition. A drawback of this study was that all were male participants, and they were all either physics students or humanities students. Varying the groups for age and gender could bring in new perspectives to the findings. Moreover, this study does not capture the level of certainty with which a participant chooses an answer. This aspect, however, was captured by Potvin et al. in a similar study (see Potvin et al. 2014 in [2]), where in addition to answering whether a circuit is correct or not, participants were asked to specify whether they're certain or uncertain about their choice. Their results support conceptual change theories that postulate that many conceptions about a single phenomenon may coexist and conflict with one another.

Overall, while the studies surveyed in [2] give us information on brain activity on conceptual learning tasks, the tasks themselves are simplistic in nature, and they do not capture the deeper complexities of learning. One such complexity that can significantly influence the cognitive process is human-to-human interaction, and this was something that was explored by Kim et al. in **[1]**, albeit without monitoring brain activity. Utilizing structural equation modelling by using AMOS, and University of California student data as mentioned earlier, they examined a hypothesized structural model for the relationship between student-faculty interaction and cognitive skills development. The model was built based on existing literature on cognitive skills development among college students, student-faculty interaction, and student motivation. Their two main findings was that the relationship between student-faculty interaction and their desired college outcome is complex, and that when students interact with their teachers, there is a positive effect on their development of cognitive skills, and, additionally, they may be exposed to various forms of challenges and responses that facilitate their development.

To appreciate the complexity of Kim et al.'s findings, it is worth looking at the subtle assumptions in their model. Their model captures indirect student-faculty interactions, such as academic self challenge, a sense of belonging, and classroom engagement. Moreover, the model assumed such indirect student- faculty interactions could have a role on cognitive skill development. Including these indirect interactions allowed them to deeply analyze the link between student-faculty interaction, student engagement, and student outcomes. Finally, to reduce bias in their model, they also included students' pre-college characteristics such as their self assessment (self-reported proficiency levels) when they entered the college, family income, gender, self-identified race, high school GPA. Including external factors in such models begs practitioners to think of more variables that could affect the model. For instance, what role does the citizenship status of students play in their cognitive development? Typically, international students are faced with different academic and career formalities, which may add to their stress levels and their outcomes? How do family circumstances [3] and any personal traumatic incidents affect students' outcomes? Collecting such data may require navigating privacy boundaries. Nevertheless, these factors are worth exploring.

Finally, from the analysis of these two works ([1, 2]), we can see an opportunity of how neuroscientific strategies for capturing conceptual change learning in [2], can be used to strengthen the interaction-oriented structural model presented in [1]. For instance, we may use brain imaging to investigate how student-faculty interactions and class activities could be made more effective. By identifying brain regions that take part in those activities, we could simultaneously identify the exact cognitive processes that get involved, and thereby provide better task design suggestions. However, while studies like [2] give broad opportunities to integrate brain data in recommendations for better conceptual learning and cognitive development, they do present significant challenges, e.g. cost and availability of brain imaging devices. Also, in order to avoid skewed results, we need to investigate and address any distractions among participants that may be introduced by such devices into the experiments these devices are deployed in.

References

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