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Accessing The Development Of The Horizontal Translation Visual Literacy Skill In Students Using Neural Networks

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Research shows that many students struggle with visual representations in molecular life science courses, which impacts their ability to learn the material. Currently, there is minimal research related to the development of students' visual literacy neural networks. This study aims to understand how students' neural networks evolve based on their chemistry and biochemistry course enrollment. For this study, students as well as experts took a survey in which their horizontal translation visual literacy skills were measured to make neural networks. Then, the students' neural networks were analyzed across the chemistry and biochemistry curricula and compared to experts' neural networks in order to answer the question: *How do the neural networks of students change throughout the different curricula in comparison to experts?* Utilizing Pathfinder, eccentricity values for each node were generated in which a low value signifies a node(s) is the most central node(s). Furthermore, the degree values indicate which node(s) has the highest degree of branching. With both these values, they can be used to look at whether the neural network of students are similar or different from the experts. These data could help create a curriculum for chemistry and biochemistry courses that could possibly improve students' visual literacy skills.

Research Question

How do the neural networks of students change throughout the chemistry and biochemistry curriculum in comparison to experts?

Study Design

Data Collection

- Survey was sent to both experts (Ph.D.'s in biochemistry or related subject) and students from UMR.
- Participants from UMR are enrolled in either a chemistry or biochemistry course.

Processing Data

- The collected data was processed in Pathfinder and then averaged to create neural networks.
- Pathfinder generated the eccentricity and degree values.

Analyzing Data

- Neural networks of students were compared to experts based on eccentricity and degree of branching
- A pair of nodes branching from one of the most central nodes in the experts' neural networks was used to measure their distance.

Data and Results

Eccentricity	2D Active Site SYM	ES Chemical Equation SCH	Specific(LDH) ES Chem Equation SCH	Enzyme inhibition CAR SCH	Enzyme reaction coordinate diagram GRA	Enzyme induced fit CAR SCH	Lineweaver-Burke GRA	Michaelis Menten formula SYM	Michaelis Menten GRA	Enzyme assay REA	Enzyme Catalyzed Arrow pushing Mechanism SCH
ES Chem Rxn Expert	5	4	5	**3**	**3**	4	4	4	**3**	4	5
CHEM1331 (CHEM1)	**4**	5	6	5	5	7	7	7	6	5	**4**
CHEM1321 (CHEM2//Ochem1)	5	5	7	5	8	6	8	6	7	7	**4**
CHEM2331 (CHEM3//Ochem2)	5	5	8	6	6	7	8	8	7	6	**4**
CHEM2332 (CHEM4//GenChem2	5	5	**3**	**3**	5	4	5	5	4	5	4
UMRBIOC3321	5	6	**4**	5	6	**4**	5	7	6	6	7
UMRBIOC3322	5	7	**4**	5	6	**4**	5	7	6	7	6

Table 1: Eccentricity values. The eccentric values of each average neural network were taken in order to measure which node(s) are the most central in each. The lower the eccentric value is, the most central the node(s) is.

Data and Results

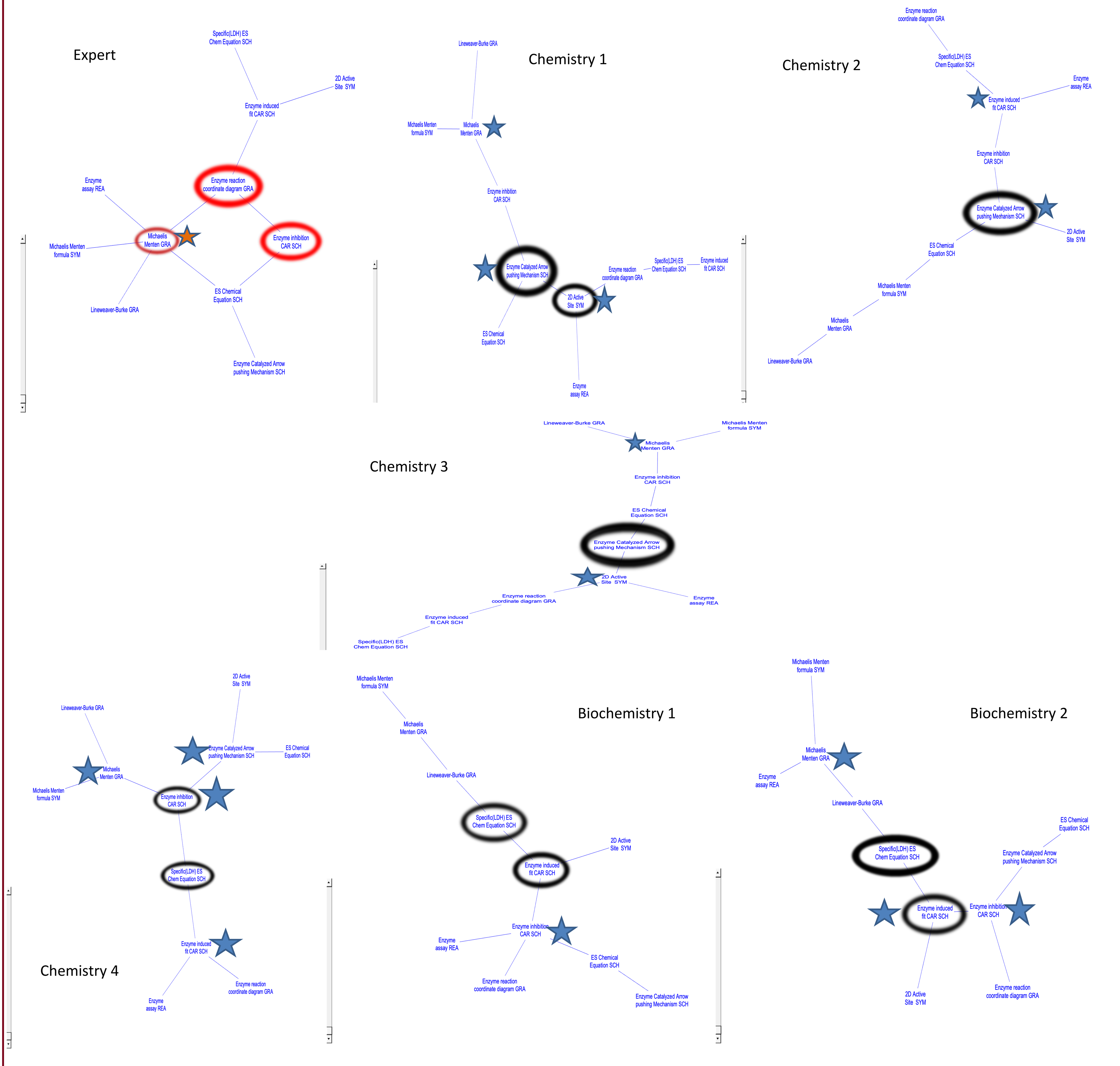

Figure 1: Neural networks. The average neural networks of the chemistry and biochemistry courses at UMR were taken using Pathfinder. Furthermore, the nodes with low eccentricity values (circled) and high degrees of branches (starred) were identified within each neural network.

Data and Results

Degree	2D Active Site SYM	ES Chemical Equation SCH	Specific(LDH) ES Chem Equation SCH	Enzyme inhibition CAR SCH	Enzyme reaction coordinate diagram GRA	Enzyme induced fit CAR SCH	Lineweaver-Burke GRA	Michaelis Menten formula SYM	Michaelis Menten GRA	Enzyme assay REA	Enzyme Catalyzed Arrow pushing Mechanism SCH
ES Chem Rxn Expert	1	3	1	2	3	3	1	1	**5**	1	1
CHEM1331 (CHEM1)	**3**	1	2	2	2	1	1	1	**3**	1	**3**
CHEM1321 (CHEM2//Ochem1)	1	2	2	2	1	**3**	1	2	2	1	**3**
CHEM2331 (CHEM3//Ochem2)	**3**	2	1	2	2	2	1	1	**3**	1	2
CHEM2332 (CHEM4//GenChem2	1	1	2	**3**	1	**3**	1	1	**3**	1	**3**
UMRBIOC3321	1	2	2	**4**	1	3	2	1	2	1	1
UMRBIOC3322	1	1	2	**3**	1	**3**	2	1	**3**	1	2

Table 2: Degree values. The degree values of each average neural network was taken to measure which nodes have the highest degree of branching.

Conclusion & Future Direction

The central nodes in most students' neural networks did not match the experts. Among the curriculums, however, the central nodes seem to overlap more possibly meaning that students continue to view the same visual representations as more centrally connected to other representations.

Throughout the curriculums, there are little visual similarities between the students' neural networks and the experts. The students' neural are more liner whereas the experts' is more concise. The neural networks in students do not seem to evolve into a similar shape as the experts'. Possibly indicating that students' networks are not evolving into that of an expert.

The degree values show there is more branching among students' neural networks. Furthermore, the degree of branching in the students' is smaller than the experts' within the same node identified as the highest degree of branching.

Future direction for this study is to create a hot spot of both the experts and students better visualize the differences and similarities between the neural networks.

References and Acknowledgements

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