THE UNIVERSITY OF WESTERN AUSTRALIA

Department of Mathematics and Statistics
Honours Programme – 2021

SUPERVISOR(S):

R. Nazim Khan, Department of Mathematics and Statistics

Prof Graham Chandler, School of Molecular Sciences

PROJECT TOPIC: The Structure of Water in Crystalline Hydrates of Metal Salts

BRIEF DESCRIPTION OF TOPIC:

The geometry of the water molecule exhibits considerable variation in crystalline hydrates of metal salts. Chandler, Wajrak and Khan [1] collected a large dataset of the structure of water in metal hydrates. They fitted linear statistical models to OH bond-lengths and HOH angles to determine their relationships with other variables. They focused on water molecules coordinated to a single cation, and then further restricted this to cations with charge 2 or 3, and then further to only those with charge 2. Finally, since there were sufficient data involving coordination of water molecules to Mg_{+} and Cu_{2+}, the model was further restricted to either of these two ions, and then to only Mg_{+} or Cu_{2+}.

They found various geometrical measurements were associated with the OH bondlength and HOH angle in the models they fitted for the data as described above. However, the paper considered only a small subset of the available data. This project considers the wider data available on water structures. The first part of the research requires the data to be appropriately formatted to enable statistical modelling. Statistical modelling is expected to include models for OH length and HOH angle two cation structures, cation pair types, and all the structures. Further data exploration may include principal components analysis and clustring. Clever and imaginative data visualisation may also reveal structure in the data.

The project would suit a student with a background in statistics or data science. Some knowledge of chemistry is desirable—Year 12 Chemistry is sufficient.

References

[1] Wajrak M. Chandler G. S. and Khan R. N. Neutron diffraction structures of water in crystalline hydrates of metal salts. Acta Cryst., B71, 2015.

PREREQUISITE SKILLS REQUIRED:

Major in statistics, or data science with sufficient statistics units at third year level.

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SUPERVISOR(S):

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PROJECT TOPIC: How do Students Learn?

BRIEF DESCRIPTION OF TOPIC:

1 Introduction

Student study habits have changed over the last two decades, driven at least in part by changes in technology. We know for example that lecture attendance twenty years ago was almost 100%, but 30% is considered good. Similarly, while previously students would submit substantial amounts of work for no credit, these days even work for credit is often not submitted. In addition, university assessment policies limit and specify the number of assessment items as well as their value.

While technology has also changed how lecture and associated material is delivered, the pedagogical practices do not seem to have changed much. There seems to be a disconnect in the expectations of academics and the practice of students. This research aims to investigate how student learning practices have changed over the last twenty years. Knowledge of the study and learning activities that student devote time to should inform teaching and modify pedagogy.

2 Research Questions

The basic question of interest is how students learn STEM subjects. The focus will be on Mathematics and Statistics since this is a largely uniform cohort. This question is made more precise as below.

1. What learning activities do students consider important?
2. What learning activities do students utilize?
3. How much time do they spend on each learning activity?
4. How does the learning activity and time spent correlate with student performance, as measured by the WAM?
5. What learning activities do academics provide?
6. What learning activities do academics consider as important for learning?
7. How does what students do inform teaching and learning?

3 Research Methodology

Data will be collected by sample surveys of students enrolled in mathematics and statistics units at UWA. Sampling will be an important consideration, with samples of appropriate sizes reflecting a

balance of students at different level of study and staff at different appointment levels. Surveys will be conducted as below.

1. Survey of students and academics. The resulting data will be analysed quantitatively to relate student performance to learning activities and time spent on each, adjusting for demographics (gender, course, HS marks etc.). Data analysis is also expected to reveal any disagreement between academics and students views on learning activities.
2. Interviews of selected students and academics. The interviews are expected to provide more detailed information on students and academics points of views.

This will be followed by focus groups of size 5 to 10 at from various levels of mathematics units with student selected at various levels of performance. Both quantitative and qualitative methods will be utilised. The focus group session will be recorded and a text analysis conducted with the aim to reveal some structure in the responses.

4 Ethical Considerations

The data will be de-identified. Appropriate ethical approval will need to be obtained.

5 Dissemination and Publication

The results are expected to be presented at appropriate conferences and also published in an appropriate journal. Further, guidelines for academics can also be prepared to inform their teaching and improve student learning.

PREREQUISITE SKILLS REQUIRED:

Major in statistics, or data science with sufficient statistics units at third year level.