Rethinking Assessment of First-Year Undergraduate Symmetry with E-Learning Techniques: A Proposed Activity

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Introduction

The knowledge of symmetry operations and point groups in first-year undergraduate chemistry is crucial for the understanding of more advanced topics in later years (Rosen, 1973), such as spectroscopy, group theory and crystallography. However, symmetry is a topic with which many first-years struggle (Carlisle *et al.*, 2015). In particular, the visualisation of molecules in 3D and applying symmetry operations presents a key challenge for many students. Strategies to overcome these challenges have been proposed, such as guided activities (Carlisle *et al.*, 2015; Luxford *et al.* 2012), 3D models (Flint, 2011) and even a periodic table of point groups derived of everyday objects (Fuchigami, *et al.*, 2016). With our proposed activity, we intend to combine the strategies of familiarity with everyday objects, peer dialogue and guided activities to aid students' understanding of symmetry operations and point groups. Pre- and post-coursework quizzes and questionnaires will be used to determine the activity's effectiveness at improving understanding and engagement.

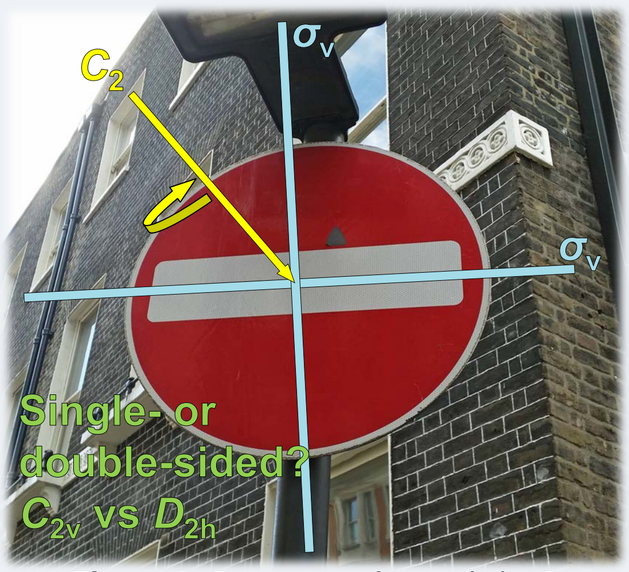

Figure 1: Symmetry of a road sign?

Table 1: Research questions and their assessment.

Research Question	Assessed Before & After By
Do students who undertake this activity show an increased attainment in the post-activity quiz compared with that taken before the activity?	Quizzes
How does any change in attainment compare with (a) students who have done no explicit set coursework and (b) students who have completed a set of coursework questions?	Quizzes
Do students who undertake the activity feel more confident in assigning symmetry operations and point groups?	Questionnaires, based on 5-point Likert scale

The Activity & Method

Group discussion and peer dialogue is known to foster deeper learning (Boyle and Nicol, 2003), so these methods will be employed during this activity.

1. Students upload photos to Moodle (UCL's virtual learning environment) of
   a) interesting everyday objects they find and
   b) models of assigned molecules.
2. Within groups, they discuss online the symmetry elements within them.
3. The group comes to a consensus on the point group of the object/molecule.

With most everyday objects, there is room for debate. For example, when considering the symmetry of a street sign, should the whole sign be included or just the face? Should the door to a building be counted or ignored? Would the symmetry be reduced or increased?

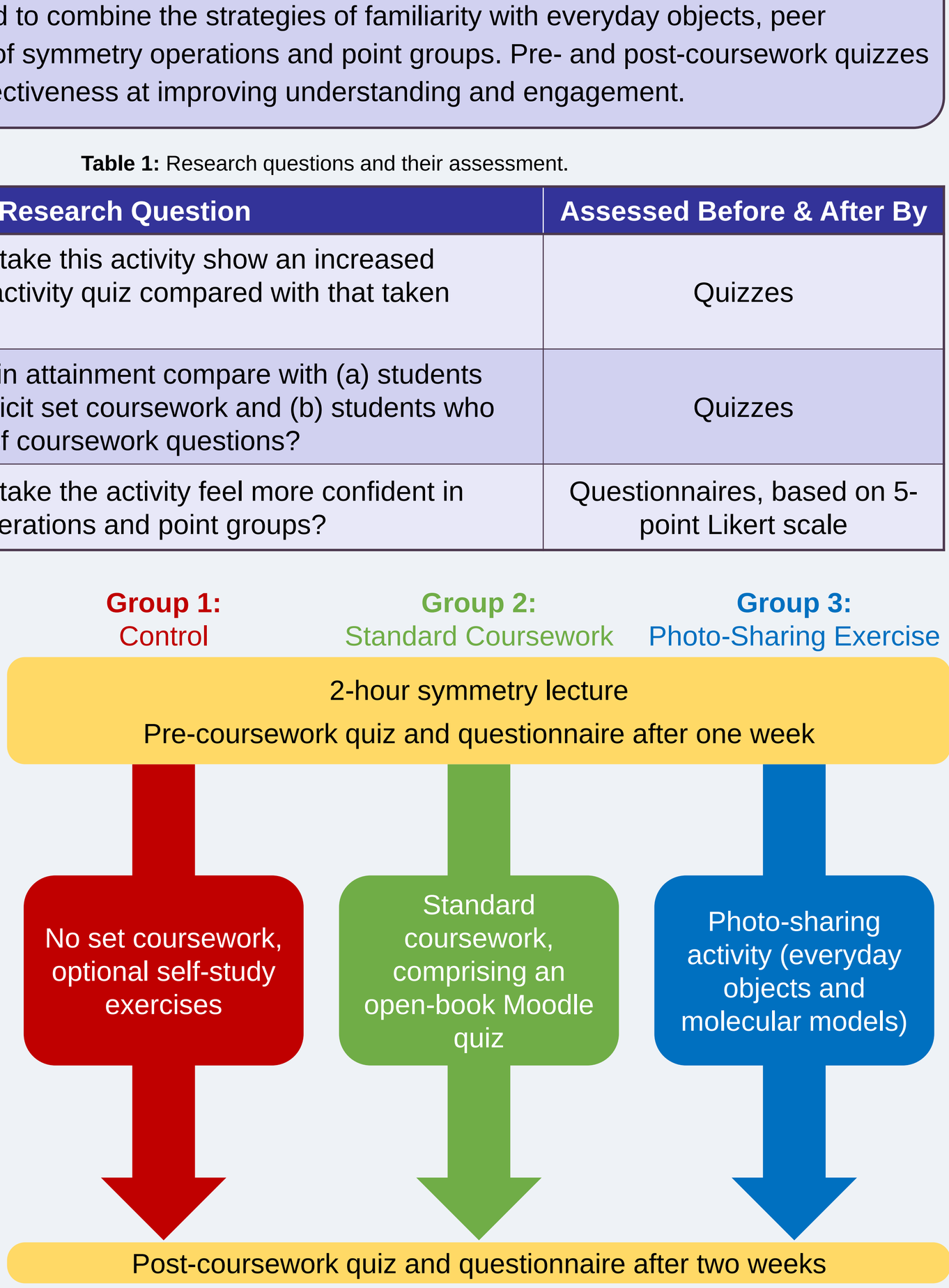

Figure 2: Schematic of how the effectiveness of the activity will be tested.

Table 2: Considerations for possible platforms for the activity.

Platform	Pros	Cons
Forum (Moodle)	+ Easily customised + Easy to grade by staff and students + High upload limit (160 MB)	– Upload procedure could be more straightforward
Database (Moodle)	+ Can be configured for image upload + Easy to download results	– Limited scope for commenting – Not clear how to grade
PeerWise	+ Students can set and rate questions + Good interaction between students	– Small 2 MB upload limit – Less staff control of format – Students rate difficulty, not quality

Possible Platforms

The platform should allow easy uploading of photos taken on devices and students should be able to comment on each other's work, rate it and discuss the symmetry. Staff should give hints and eventually grade students on the quality of discussion.

References

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