Designing a New Interdisciplinary Module on Medicinal Radiopharmaceutical Chemistry: A Feasibility Study

Dr Maung Maung Saw
Clinical Imaging Research Centre, Yong Loo Lin School of Medicine

Increasing Importance of Interdisciplinary Education

Interdisciplinary education has become increasingly important in recent years as society faces increasingly complex challenges that do not fall within just one discipline. According to Holley (2009a), disciplinary concentration of faculty, student, and knowledge are no longer the *de facto* norm for institutions. In fact, more institutions are adopting the interdisciplinary approach in their teaching, which is characterised by flexibility, innovation and the creation of new constructs for dealing with complex issues (Stone, Bollard & Harbor, 2009). We need to distinguish this from the multidisciplinary approach to teaching: interdisciplinarity refers to an integrative process or relationship, while multidisciplinarity refers to an additive process which combines separate disciplines in the pursuit of an overarching question or topic (Davis, 1995; Holley, 2009b). Similarly, Mansilla and Duraising (2008) define interdisciplinarity as an approach educators use “to integrate knowledge or modes of thinking in two or more disciplines or established areas of expertise to produce a cognitive advancement ... in ways that would have been impossible through [a] single disciplinary means”.

Medicinal Radiopharmaceutical Chemistry: A Solid Example of an Interdisciplinary Subject

Chemistry has diversified in many new directions and medicinal chemistry is one striking example which crosses a few disciplinary boundaries: organic chemistry, inorganic chemistry, pharmacy, pharmacology, drug development process, biology and so on. Medicinal radiopharmaceutical chemistry cuts across even more boundaries, such as nuclear instrumentation, radiation physics, radiation mathematics, instrument automation, drug design, regulatory affairs related to medicinal compounds, pathophysiology, molecular biology, research and development techniques apart from these mentioned above.

My Personal Teaching Philosophy

I am a proponent of multidisciplinary learning and teaching, as I believe it is one of the best ways to bring lessons learnt from the various classrooms to real life, equipping students with the knowledge and skills to solve complex everyday problems in a harsh out-of-classroom environment. However, the question is—how scientifically or artfully could these multiple factors be effectively integrated, resulting in a successful single coherent theme, effect or solution?

Recommended Citation

As a part of the PDP-T teaching practicum, I conducted a feasibility study on the design of a new interdisciplinary module on medicinal radiopharmaceutical chemistry. Acceptance and meeting learning objectives were measured by compiling and analysing the engagement levels of the audience in response to a fixed-theme presentation.

**Student Engagement**

As defined by Natriello (1984), student engagement is seen as students “participating in the program activities”. A more recent definition by Skinner and Belmont (1993) refers to it as students “showing positive emotions during on-going action”, or “showing sustained behavioural involvement in learning activities accompanied by a positive emotional tone”.

How is student engagement measured? According to Elaine Chapman (2003), it can be measured in five ways;

1. **Self-Reports**—affective engagement questions which typically ask students to rate their interest in and emotional reactions to learning tasks on indices,

2. **Checklists and Rating Scales**—summative rating scales to measure student engagement levels,

3. **Work Sample Analyses**—evidence gathered from student projects, portfolios, performances, exhibitions, and learning journals or logs, suitable for use in classroom situations,

4. **Focused Case Studies**—restricted to a small target group of students, to collect detailed descriptive accounts of engagement rates, and

5. **Direct Observations**—momentary time sampling system, which records whether the desired learning behaviour is present or absent during a specific time period, in class-wide observations.

**Study Design**

I had given a presentation with the same core material to a range of target audiences (see Table 1). The only difference is the length of the presentations (between 1 to 3 hours) and emphasis on certain parts depending on the target audience. I used the direct observation method to determine audience engagement levels.

The presentation covers the construction of a targeted radiopharmaceutical (the presentation’s overarching subject theme being medicinal radiopharmaceutical chemistry)

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**Table 1. List of target audiences.**

<table>
<thead>
<tr>
<th>No</th>
<th>Audience</th>
<th>Organiser/Place</th>
<th>Class Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scientists (Molecular Imaging)</td>
<td>Various Departments</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Faculty members</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Food Sciences Technology</td>
<td>Food Sciences Technology Department, NUS</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>b. Medicinal Chemistry</td>
<td>Medicinal Chemistry Programme, NUS</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>MSc by course work students</td>
<td>Department of Chemistry, NUS</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Chemistry Honours students</td>
<td>Department of Chemistry, NUS</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Nuclear Medicine Physicians</td>
<td>Department of Diagnostic Imaging, NUH</td>
<td>5-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Department of Nuclear Medicine and PET, SGH</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Radiochemist/ Radiopharmacist</td>
<td>Various Radiopharmacy Units in other countries (Vietnam, Philippines, Thailand, Mongolia, Egypt)</td>
<td>3-10</td>
</tr>
<tr>
<td>7</td>
<td>Junior College School Teachers</td>
<td>Medicinal Chemistry Programme, NUS</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>Radiographers</td>
<td>Department of Diagnostic Imaging, NUH</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>Nanyang Polytechnic, Year 3</td>
<td>Nanyang Polytechnic, Year 3 Radiography course moderators</td>
<td>35</td>
</tr>
</tbody>
</table>
by a combination of the following key elements: radioisotopes (nuclear chemistry, nuclear physics), targeting biomolecules (biology), bifunctional chelators (organic chemistry, coordination chemistry), probe design (medicinal chemistry), purpose of radiopharmaceuticals as agents for medical imaging (nuclear instrumentation) (See Figure 1).

This single presentation is designed as a pilot to determine the audience’s response to an interdisciplinary topic.

The same presentation style was used across all sessions to ensure consistency. The aim of my presentation, i.e., that students attain a basic understanding of medicinal radiopharmaceutical chemistry, was clearly conveyed to the audience before I began. I started by explaining fundamental knowledge relevant to the module, used examples to show how the respective topics in the basic sciences were linked to real-life products or processes using examples, and how a particular subject/topic was or could be iteratively linked to other disciplines in developing a new product or discovering a mechanism.

As mentioned early, the direct observation method was used to determine audience engagement levels. Approximately 5 minutes for each target audience per lesson were allocated. As the audience size was between 5 to 30 students, majority of the audience could be sampled for behavioural observation.

The following behaviours were noted as positive indicators:

- enthusiasm, optimism, curiosity, interest,
- asking relevant questions, and
- participating in relevant discussions.

The following behaviours were noted as negative indicators:

- disaffection,
- passive, bored, depressed, confused,
- withdrawn from learning opportunities, and
- rebellious towards teacher and classmates.

Feedback from the course organisers were also collected via email response and short discussion after the presentation. Classroom behavioural observations and feedback from the course organisers were then analysed and integrated as a general score rating of one to five, as follows:

Score 1: Disastrously failed to engage,
Score 2: Failed to engage,
Score 3: Not satisfactory,
Score 4: Satisfactorily engaged, and
Score 5: Very satisfactorily engaged.
Results & Discussion

Results of the analysis are mentioned in Figure 2.

In general, the interdisciplinary topic on medicinal radiopharmaceutical chemistry was well received and engaged the audience. Highly complex subjects might not be suitable for undergraduate students with focussed studies, as evident from the lower satisfactory score given by the polytechnic students (see Figure 2). A more subtle or convincing way of presenting the content will be required. The audience should be selective, rather than broad-based. The creation of new interdisciplinary modules may require a suitable home ground which is adaptable and able to accommodate a new form of teaching which crosses many disciplinary boundaries.

It was better perceived by the audience who were either inclined, pre-conditioned or adaptable towards creative thinking, medicinal applications and cross-boundary learning, such as the Chemistry Honours students and graduate students doing MSc by course work (see Figure 2). In fact, a number of students had chosen interdisciplinary topics despite being presented with a multitude of choices for their research module. It is a very encouraging sign, though the percentage of those within the student population who are interested have yet to be determined. One of the more surprising findings was that this topic was enthusiastically received by junior college (JC) teachers. That might mean interdisciplinary thinking is an area of current interest for them.

This feasibility study gave me assurance that adopting an interdisciplinary approach is well worth further exploration, leading to the creation of a new interdisciplinary module and submission to the curriculum committee for consideration. Based on the findings in my practicum and this article, I have since created a module, MDG5225 “Fundamentals of Molecular Imaging”, with approval from my department. The School has been offering this module since Semester 1 of AY2012/2013. Another module, MDG5228 “Hybrid Imaging: An Advanced Imaging Concept and Modality” has been approved by the Board of Graduate Studies and will be offered in the next semester (Semester 1, AY2013/2014).

Endnote

1. Chelation describes a particular way that ions and molecules bind metal ions.

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About the Author

Dr Maung Maung Saw currently teaches the graduate module MDG5225 “Fundamentals of Molecular Imaging”. As a proponent of interdisciplinary teaching, he is pleased to see that a number of graduate students from different faculties have enrolled into this module and are enjoying the class.