A neuroscience pull-out gifted program in a high school in Hong Kong: Connection of neurodegenerative diseases and traditional Chinese medicine in research-based learning

Ka-Chun Suen\textsuperscript{1}, Man-Ho Li\textsuperscript{1}, Wing-Kwong Chan\textsuperscript{1}, Raymond Chuen-Chung Chang\textsuperscript{2}

\textsuperscript{1}Po Leung Kuk Laws Foundation College, Tseung Kwan O, Hong Kong, China
\textsuperscript{2}Laboratory of Neurodegenerative Diseases, Department of Anatomy, Li Ka Shing Faculty of Medicine, The University of Hong Kong, Hong Kong, China

\textbf{Introduction}

The development of Neuroscience curriculum in our school (a high school in Hong Kong): Published previously in

2007 Research-based learning associated with an authentic topic can promote active learning in high school neuroscience lessons

2008 Brain cell culture is an effective learning activity for high school students to acquire diverse knowledge and skills about neuroscience

2010 Development of a school-based neuroscience curriculum in a high school in Hong Kong

2013 An example of a high school in Hong Kong to develop a school-based Neuroscience curriculum as a pull-out program for scientifically gifted students

In our school, the Neuroscience curriculum mentioned above was run by Neuroscience Club which was a pull-out class for the scientifically gifted students.

The Purdue Three-Stage Enrichment Model (Feldhusen 1973) was adopted in our pull-out Neuroscience class to move students from simple thinking experiences to complex independent activities (VanTassel-Baska 2007).

\textbf{The Objective of our present report}

To study how neurodegenerative diseases and traditional Chinese medicine can be connected as learning activities in the Purdue Three-Stage Enrichment Model in the pull-out Neuroscience curriculum.

\textbf{Curriculum design}

As there was no any topic about neurodegenerative diseases and traditional Chinese medicine in high-school science curricula in Hong Kong, we introduced them in our pull-out neuroscience program as challenging and enriching learning topics in science.

Neurodegenerative diseases and traditional Chinese medicine were then connected as learning activities in the Purdue Three-Stage Enrichment Model as follows:

\textbf{Stage I:}

<table>
<thead>
<tr>
<th>Learning objective</th>
<th>Learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery of core contents on brain structure, morphology of neurons, characteristics of neuronal cell death and basic chemistry (e.g. concentration); Mastery of technical skills on cell culture</td>
<td>Taught class, self reading and student’s presentation on selected topics</td>
</tr>
</tbody>
</table>

\textbf{Stage II:}

<table>
<thead>
<tr>
<th>Learning objective</th>
<th>Learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery of the above core contents with enhancement on complex problem-solving abilities</td>
<td>Practical preparation of different concentrations of extracted traditional Chinese medicine; literature review on agents which can cause neuronal cell death in Alzheimer's disease; investigation on different concentrations of the toxic agents (e.g. H\textsubscript{2}O\textsubscript{2}) to kill neurons; investigation on the morphological changes in neurons treated with the toxic agents; literature review on the functions of traditional Chinese medicine</td>
</tr>
</tbody>
</table>

\textbf{Stage III:}

<table>
<thead>
<tr>
<th>Learning objective</th>
<th>Learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of student’s abilities to apply knowledge to solve real problems as a scientist</td>
<td>Research-based learning: Students in groups develop a scientific research to study the neuroprotective effects of traditional Chinese medicine in neuronal cells</td>
</tr>
</tbody>
</table>

Stage-III learning activities were repeated when students started a study on a new traditional Chinese medicine.

\textbf{Evaluation}

Four scientifically gifted students aged 14-15 were identified and selected to join Neuroscience Club. They did stage-I and stage-II activities once. These pupils repeated stage-III activities for 4 times (i.e. studying 4 types of traditional Chinese medicine) within 6 months.

Qualitative data by teacher’s observation:

1. All of the students showed high interest towards looking for medicine to rescue neurons.
2. The students were able to plan and conduct 5-day experiment (seed cells, grow cells, pre-treat cells with Chinese medicine, treat cells with H\textsubscript{2}O\textsubscript{2} and do LDH essay for cell death study).
3. In terms of data accuracy, the students had developed a sense of repeating experiments.
4. The students were able to do a fair test.
5. About the Nature of Science, the students realized the limitations of science and scientific methods.