Mathematics and Chemistry an Inseparable Companion in Science and Technology Education

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Abstract

Knowledge has become a way of developing life as the world is now a global village. Components of many of the basic subjects such as chemistry involve mathematics while there is a general perception that students’ performance in these subjects may be influenced by their vested interest in mathematics but there is a dearth of information on this. This study investigated the inseparable companion of mathematics and chemistry in fostering science and technology education through students’ perceived knowledge of mathematics (PKM), its relationship with chemistry (RMC) and the perceived influence of mathematics knowledge (IMKC) on students’ performance in chemistry. The internal consistencies of the instruments were 0.75, 0.81 and 0.67 respectively using Cronbach alpha. The study is a descriptive research of the cross sectional survey type. 475 students were randomly selected from 10 Secondary Schools in Oyo State. while one intact class was randomly selected from each school. A researcher designed questionnaire was used for collecting data for the study. It was discovered that chemistry students perceived that they have adequate knowledge of mathematics to apply to related fields of study especially chemistry, knowledge of mathematics relates with chemistry and students’ perceived knowledge of mathematics influence their performance in chemistry. The results of this research work suggest that students who are very sound in mathematics perform better in chemistry.

Key words: Knowledge, perception, Performance, Science

Introduction

Knowledge Creation from one generation to another has enabled planning and preparation. In today’s highly dynamic educational environment, knowledge is an added advantage. The ability to create knowledge is the main source of development for today and the future (Ogunlade & Olafare, 2012) and this ability is the main source of development for today and the future which can be achieved through the knowledge of mathematics. Mathematics can be linked to any field of study and can be applied to every area of life. In short, society and mathematics are both better off because of the application of mathematical theories to societal development. Mathematics has its influence in chemistry. There are some tools produced in mathematics useful for chemistry.

Chemists use group theory to study aspects of their field (Malkevitch 2017). This group theory is one of the tools in mathematics. Malkevitch (2017) states further that it was
revolution to develop an experimental approach to chemistry carrying out procedures under controlled circumstances and seeing if one get repeatable results. Controlled experiments open the doors to using mathematical tools from statistics and from the field of experimental design.

Measurement is another aspect of mathematics that is very useful in chemistry. Different units in measure are being used in chemistry such as centimeter (cm), inch (in), foot (ft), meter (m), kilometer (km) for length; gram (g), kilogram (kg) for mass. Second (s), minute (min), hour (hr), for time, area (unit) sq, density kg/m³ or kgm⁻³, acceleration. m/g² or mg². The natural sciences involve observation and numerical measurements of quantities such as length, volume, temperature, density and the concentration of chemical solutions. The measurement referred to is a tool in mathematics and its application can be made use in chemistry and other natural sciences. Most of the above quantities mentioned have units associated with them which must be retained when use in calculation.

Chemistry involves the creation of molecules from the atoms that occur naturally. According to Malkervitch (2017) there are 92 naturally occurring elements in chemistry with complex properties, some are gases, some are liquid and some are solid at room temperature. From the beginnings of chemistry, mathematics was used to create quantitative and qualitative models to comprehend the world of chemistry by understanding the elements that make up molecules. An atom is made up of particles known as protons, neutrons and electrons. Chemistry is concerned with measurement issues concerning these particles protons, neutrons’ and electrons have mass and electrical charge that can be measured. Numbers have been used to understand the structure of the 92 naturally occurring elements and to classify them into families with similar kinds of chemical properties, which lead to the formation of the periodic table. This helps in organizing the elements into groups which have similar properties and then was the information to understand the properties of these elements.

Mathematical calculations are absolutely used to explore important concepts in chemistry. Without the knowledge of some basic mathematics skills, chemistry as well as the calculation in chemistry will be extremely difficult. Some of the skills needed include: calculator fundamentals, numbers and their properties, ratios and properties, units, diversions and conversions, percent’s, simple statistics, indices and logarithms also, interpretation of graphs.
In other words, to explain the behavior and properties of atoms and molecules, mathematical explanation has to be relied on. Chemistry is therefore an Applied mathematics. To better prepare for chemistry the students should take more mathematics classes. A general chemistry students’ mathematical preparation is directly related to their performance. From the research study carried out by Grove and Pugh (2015) to investigate the specific nature of the mathematical issues affecting chemistry students, it was identified that, there is a need to create a resource that would not only provide an overview of key mathematical ideas and concepts, but would also give examples of the kinds of chemistry problems that require mathematics. It was suggested that there should be continual opportunities for students to apply and develop their mathematical skills throughout all aspects of their course and key mathematical ideas, concepts and results should not be hidden from students, but should be presented in ways that they can understand and appreciate.

Mathematics is regarded as a useful tool by chemists, all chemistry students need to pay attention to the study of mathematics in order to access and make the most of their science. There are various levels of mathematics used in chemistry, ranging from proportional reasoning to heavy-weight differential equations and Fourier analysis, study of any of the underlying mathematics reduce mathematical activity to a series of clean, dry routines and procedures. According to Hewson (2011), many students then struggle with applying the quantitative knowledge in the complicated chemical contexts encounter. According to Flapan, Hemkin, Robinson, Schrier, Seeman and Simion, mathematical confidence and problem solving ability are probably the most important factors in predicting the success of students in chemistry. However, knowledge and skills in the areas of basic mathematics, calculus, and 3dimensional geometry as described below, can be useful as a prerequisite to general chemistry. It was also emphasized that, It is unlikely that a student will excel in general chemistry without a solid understanding of and facility with the following basic mathematics topics: unit conversions, significant figures, proportions and concentrations, expressions involving exponents and logarithms, basic trigonometry and algebra including graphing, summation notation, probability and statistics and applications of all of the above to word problems.

The following table consists of the on how some contents in mathematics relate with chemistry.
Table 1: Contents in Mathematics and how Related to Chemistry

<table>
<thead>
<tr>
<th>Mathematics</th>
<th>Chemistry Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratios</td>
<td>Mixing solutions with certain molarities, making dilutions</td>
</tr>
<tr>
<td>Proportional</td>
<td>Analysis of molecular structure; moles</td>
</tr>
<tr>
<td>reasoning</td>
<td></td>
</tr>
<tr>
<td>Algebra and graphs</td>
<td>Analysis of experimental plots of reaction rates; gas laws</td>
</tr>
<tr>
<td>Calculus</td>
<td>Predicting and measuring rates of reaction in measurable experiments</td>
</tr>
<tr>
<td>Units of</td>
<td>Making sense of real, complicated measurements</td>
</tr>
<tr>
<td>measurements</td>
<td></td>
</tr>
<tr>
<td>Vectors</td>
<td>Understanding crystal structure</td>
</tr>
<tr>
<td>Logarithms</td>
<td>Understanding pH</td>
</tr>
<tr>
<td>Probability</td>
<td>Drawing general conclusions from trials</td>
</tr>
</tbody>
</table>

Zambrini (2006) also states that chemistry is an exact science that relies on quantitative models that can be described and applied by using the mathematical language. The theory of chemical bonding and molecular structure, rates and equilibria of chemical reactions, molecular thermodynamics, relationship involving energy, structure and reactivity, modeling of salvation have problem whose solutions require sophisticated mathematical techniques. In applied chemistry and chemical engineering, mathematics plays central role examples of these include atmospheric chemistry, biochemistry and computer simulations.

**Objective of the study**

The objectives of this study include the following:

1. To investigate how chemistry students’ perceived knowledge of mathematics.
2. To find out if there is any relationship between mathematics and chemistry.
3. To find out whether mathematics knowledge influences students’ performance in chemistry.

**Research Question**

The followings questions were answered:

- What is the perception of chemistry students about their knowledge of mathematics?
- Is there any relationship between knowledge of mathematics and chemistry, what is the perception of chemistry student on that?
- How do students’ perceived knowledge of mathematics as influence the performance in chemistry?

**Methodology**

The study is a descriptive research of the cross sectional survey type. The sample consist of 475 chemistry students randomly selected from 10 Secondary Schools in Oyo State from five Local Government areas randomly selected from the list of Local Government areas in Oyo state. Two secondary schools were selected randomly from each and one intact class also selected randomly from each school. A researcher designed questionnaire of perception of students in knowledge of Mathematics (PKM), relationship between mathematics and chemistry knowledge (RMC) and influence of mathematics knowledge on chemistry (IMKC) was used to collect data. It consists of 2 sections. Section A was on bio-data information of the respondents. Section B consists of three sub-sections with five (5) questions each to make a total of 15 questions. The instrument was validated. The internal consistency of the instruments was 0.75, 0.81 and 0.67 respectively using Cronbach alpha.

**Results**

- What is the perception of chemistry students about their knowledge of mathematics?

<table>
<thead>
<tr>
<th>S/N</th>
<th>Knowledge of Mathematics</th>
<th>Mean (X)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Solving of mathematics problem is not difficult for me</td>
<td>2.80</td>
<td>Accepted</td>
</tr>
<tr>
<td>2.</td>
<td>Having good knowledge of mathematics helps a lot in solving real life problem</td>
<td>2.98</td>
<td>Accepted</td>
</tr>
</tbody>
</table>
3. There is a creativity in mathematics 2.69 Accepted
4. I always get good grades in mathematics 3.47 Accepted
5. The knowledge of mathematics is always useful for application to other fields of study 3.43 Accepted

Grand Mean 2.50 Accepted

The result on table 2 revealed that the respondent admits that solving of mathematics problem is not difficult, having good knowledge of mathematics helps a lot in solving real life and problem and there is creativity in mathematics had mean scores of 2.80, 2.98, and 2.69 respectively. More so, respondents always get good grades in mathematics and knowledge of mathematics is always useful for application to other fields of study had a mean score of 3.47 and 3.43 respectively were accepted. The average mean score of mathematics students’ perception of their knowledge of mathematics on table 2 was 2.50 and this was also accepted. This also translated to 62.5%. With this result, it was postulated that chemistry students perceived that they have adequate knowledge of mathematics to apply to related fields of study.

- Is there any relationship between knowledge of mathematics and chemistry, what is the perception of chemistry student on that?

Table 3: Students Perceived Knowledge of Mathematics as Related to Chemistry

<table>
<thead>
<tr>
<th>S/N</th>
<th>Mathematics as related to Chemistry</th>
<th>Mean (X)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Every concept in chemistry has mathematical interpretation</td>
<td>3.41</td>
<td>Accepted</td>
</tr>
<tr>
<td>2.</td>
<td>Chemist must have adequate knowledge of mathematics</td>
<td>3.21</td>
<td>Accepted</td>
</tr>
<tr>
<td>3.</td>
<td>My knowledge of mathematics makes me perform better in chemistry</td>
<td>3.09</td>
<td>Accepted</td>
</tr>
<tr>
<td>4.</td>
<td>I adequately apply my knowledge of mathematics to chemistry</td>
<td>3.29</td>
<td>Accepted</td>
</tr>
<tr>
<td>5.</td>
<td>Chemistry concepts require mathematical interpretation at all levels</td>
<td>2.92</td>
<td>Accepted</td>
</tr>
</tbody>
</table>

Grand Mean 3.18 Accepted
The result on table 3 revealed that the respondent admits that every concept in chemistry has mathematical interpretation, chemists must have adequate knowledge of mathematics and ability to solve mathematical problems and my knowledge of mathematics makes me perform better in chemistry had mean scores of 3.41, 3.21, and 3.09 respectively. More so, respondents adequately apply the knowledge of mathematics to chemistry and also believe that chemistry concepts require mathematical interpretation at all levels had a mean score of 3.29 and 2.92 respectively were accepted. The average mean score of how students’ perceived knowledge of mathematics relates with chemistry on table 3 was 3.18 and this was also accepted. This also translated to 79.5%. With this result, it is postulated that chemistry students perceived knowledge of mathematics relates with chemistry.

**How do students’ perceived knowledge of mathematics as influence the performance in chemistry?**

**Table 4: Students’ Perceived Knowledge of Mathematics As it Influence their Performance in Chemistry**

<table>
<thead>
<tr>
<th>S/N</th>
<th>Influence</th>
<th>Mean (X)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I perform better in chemistry based on the knowledge of mathematics</td>
<td>3.00</td>
<td>Accepted</td>
</tr>
<tr>
<td>2.</td>
<td>Having knowledge of mathematics affects performance in chemistry</td>
<td>3.20</td>
<td>Accepted</td>
</tr>
<tr>
<td>3.</td>
<td>Students do perform well in chemistry with the knowledge of mathematics</td>
<td>2.34</td>
<td>Accepted</td>
</tr>
<tr>
<td>4.</td>
<td>Mathematics concepts are pre-requisites to some topics in chemistry</td>
<td>2.49</td>
<td>Accepted</td>
</tr>
<tr>
<td>5.</td>
<td>Creativity in mathematics influence students’ performance in Chemistry</td>
<td>3.43</td>
<td>Accepted</td>
</tr>
<tr>
<td></td>
<td><strong>Grand Mean</strong></td>
<td>2.80</td>
<td>Accepted</td>
</tr>
</tbody>
</table>

The result on table 4 revealed that the respondent admits that they perform better in chemistry based on the knowledge of mathematics, knowledge of mathematics affects performance in chemistry and perform well in chemistry with the knowledge of mathematics had mean scores of 3.00, 3.20, and 2.49 respectively. More so, respondents Mathematics concepts are
pre-requisites to some topics in chemistry and also Creativity in mathematics influence students’ performance in Chemistry had a mean score of 2.49 and 3.43 respectively were accepted. The average mean score of students’ perceived knowledge of mathematics influence their performance in chemistry on table 4 was 2.80 and this was also accepted. This also translated to 70.0%. With this result, it is postulated that students’ perceived knowledge of mathematics influence their performance in chemistry.

Discussion

From the findings of the study, it was discovered that, chemistry students perceived that they have adequate knowledge of mathematics to apply to related fields of study. Adequate knowledge of mathematics helps a lot in other areas of study not limited to chemistry alone. This is in line with study carried out by Soleymani and Rekabdar (2016) on the relation between mathematics self-efficacy and mathematics achievement with control of mathematics attitude, the results show that there is a significant relationship between self-efficacy and mathematics achievement. It was also discovered in this study that, In this case, students that want to study chemistry must take more mathematics classes since a general chemistry student’s mathematical preparation is directly related to their performance. Also, Goodhart (2013), emphasized that, the mathematics knowledge students had prior to the general chemistry may have allowed them to understand certain chemistry topics more quickly and easily, although the overall effect was not to raise the grade on his study on mathematics and chemistry connections.

Conclusion

According to the information gathered from the study on how chemistry students perceived their knowledge of mathematics, it was concluded that chemistry students perceived that they have adequate knowledge of mathematics to apply to related fields of study, that knowledge of mathematics relates with chemistry and knowledge of mathematics influence the students’ performance in chemistry.

Recommendation

Since the knowledge of mathematics is very important in studying chemistry, the students of chemistry must find a way of attending more mathematics classes. Students are encouraged
to attend tutorial classes in mathematics to improve their knowledge in the subject. The use of ICT is very important especially in the learning of mathematics, in this case, the students of mathematics and chemistry should be encouraged in using this medium in learning.

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