International Baccalaureate Science Teachers’ Choices in Curriculum and Instruction

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Research

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ABSTRACT

This study was designed to investigate the choices International Baccalaureate (IB) science teachers make for Internal Assessment (IA). Data was gathered via a survey of IB science teachers. Their responses were analyzed based upon the teachers’ demographics. IB science teachers use a variety of IA activities, with hands-on activities and worksheets being most common. They do not emphasize inquiry although some aspects are included. They prefer to use activities designed by themselves or other teachers.

Key Words

International Baccalaureate, internal assessment, inquiry
Introduction

Increased rigor in curriculum is a continuous focus among researchers, educators, parents, politicians, and the public. Literacy in educational areas such as reading, mathematics, and science is constantly being examined. Although some urge that caution should be used when comparing United States curriculum and practices globally, there is a move “toward a common yardstick.” (Cavanaugh, 2009) In this age of concern for increased rigor, literacy, and the positive social and intellectual development of our students, there is one curricular program that has gained increased recognition as fulfilling many of the aspects deemed essential for a quality program. This program is the International Baccalaureate (IB) program. The International Baccalaureate Organization (IBO) website states,

“The International Baccalaureate® (IB) is a non-profit educational foundation, motivated by its mission, focused on the student. Our three programmes for students aged 3 to 19 help develop the intellectual, personal, emotional and social skills to live, learn and work in a rapidly globalizing world. Founded in 1968, we currently work with 3,371 schools in 141 countries to develop and offer three challenging programmes to over 1,010,000 students aged 3 to 19 years.” (“About the International Baccalaureate,” n.d.)

Their mission statement is:

The International Baccalaureate aims to develop inquiring, knowledgeable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect. (International Baccalaureate, 2005-2007, Mission, p. 1)

Currently there are 762 IB diploma high schools in the United States and its territories.

The IB program is a high school diploma program which, along with a core of six subjects, science, mathematics, history, communication arts, fine arts, and foreign language, requires all students to complete three additional components. These include: an extended essay about a research topic of their choice; a theory of knowledge (TOK) class; and a creativity, action, and service (CAS) component where students volunteer in various programs and community activities. Along with the separate TOK class, there are TOK objectives included in each of the six subject areas. IB teachers are encouraged
to teach some of the objectives while others are a required part of the tested curriculum. These objectives lend themselves to more open-ended discussions in student inquiry.

IB science includes biology, chemistry, and physics. Curriculum within each group includes: major topics of study; options which explore these topics in more depth; and Internal Assessments (IA). The IA is the practical laboratory work students complete under the direction of their teacher. Students complete between forty and sixty hours of activities which support the topics of the course. At the end of the course students complete a culminating examination which assesses their knowledge of the curriculum area. Part of students’ final score is based upon their completion of the IA portion which includes a minimum of two open inquiries.

Support is widespread that students should experience inquiry in science classrooms (Lunetta et al., 2007), although there are disagreements about definitions for inquiry (Asay & Orgill, 2010; Minner, Levy, & Century, 2010) and different styles of inquiry are found in the literature (Asay & Orgill, 2010). One of the aims of the IB program is to “develop inquiring minds” (International Baccalaureate 2005-2007) in students and one of the main focuses of current reform in science education is to integrate inquiry-based practices in science classrooms (National Research Council [NRC], 1996, 2002). This research focuses upon the choices IB science teachers make regarding inquiry. This study was conducted prior to the release of the frameworks for K-12 science (NRC, 2011).

Review of Literature

Rigorous science curriculum has gained increased focus since the No Child Left Behind (NCLB) Act (2002) was signed into law. One component of the act is to provide for the improved academic achievement of students by encouraging educational entities to “develop more rigorous mathematics and science curricula that are aligned with challenging state and local
content standards and with the standards expected for postsecondary study in engineering, mathematics, and science” (NCLB, 2002, p. 1643).

“Engaging students in more challenging coursework (that) appears to boost learning and achievement” (Clemmitt, 2006, p. 1) is a goal of both the IB and Advanced Placement (AP) programs. A study by the NRC examined AP and IB programs by focusing on questions about advanced study to gain “improved, research-based understanding of teaching and learning” (Gollub, Bertenthal, Labov, & Curtis, 2002, p. 1). This study relied on materials and testimony from individuals who were officials of the organizations, teachers for the programs, or students in the two programs. There were two areas of emphasis in the study on the consistency of the programs: (a) research on cognition and learning and (b) availability of equal access to the advanced study programs. They reported “frequent inconsistencies” (p. 2) with both programs on cognition and learning research, and limited access to these programs for minorities and students in inner-city and rural schools. An ERIC search found only two studies on IB. One (Talbot, 2000) focused on TOK in science. The other (Mathews and Kitchen, 2007) investigated stakeholders’ impressions of the IB program as a “school within a school” gifted program.

The National Center for Education Statistics, as part of the National Assessment of Educational Progress (NAEP) High School Transcripts Study (2007), showed “high school graduates who took neither AP/IB mathematics courses nor AP/IB science courses earned a lower overall mean GPA than the AP/IB course-taking subgroups” (Perkins, Kleiner, Roey, & Brown, 2004, p. 2). Sadler and Tai (2007) investigated whether it was better for students preparing for college to take an AP course and get a lower grade or take a “regular” course and get an A grade. They found when taking variations in college grading systems into account, there was “strong evidence to support adding bonus points to students’ high school course grades
Achievement levels of students who participated in AP or IB programs have been examined in two empirical studies. The Pfeiffenberger, Zolanda, and Jones (1991) study focused on the dynamics of writing tests for AP physics and examined data from the National Assessment of Educational Progress (NAEP) and the International Assessment of Educational Progress on physics achievement. The discouraging news was that “student performance seldom meets the expectations of the test development committees…and…low rate of participation among women and some minorities” (p. 37). They reported that from 1956-1990 there was an increase in the number of students taking the AP exam but not a significant decrease in the scores on the examination. Poelzer and Feldhusen (1996) noted IB students in all science areas had higher achievement levels on pre and post tests administered than did non-IB students.

There is controversy regarding whether AP or IB courses affect persistence to college graduation or performance in college. Klopfenstein and Thomas (2005) stated, “Our findings suggest that while a rigorous high school curriculum clearly impacts the likelihood of early success in college, AP courses are not a necessary component of a rigorous curriculum” (p. 14). In contrast, Adelman (1999, 2006) concluded that a rigorous high school course load is a factor in college success, with AP courses being one factor that influenced completion of a bachelor’s degree. He concluded that “taking at least three Carnegie Units in core laboratory science (biology, chemistry, and physics) is more critical than taking AP classes, even though AP courses contribute to the highest level of academic intensity in a high school curriculum” (2006,
The only studies that have examined curriculum taught in high school classrooms have been sponsored by the AP and IB organizations reported on their web sites.

Although discussion regarding rigorous curriculum tends to include both AP and IB, there are distinct differences. Matthews and Hill (2005) noted, “Unlike most AP courses, an IB course does not allow students to skip the final examination without penalty” (p. xii). They described the differences between the two examinations:

It is one thing for students to prepare for AP examinations in subjects they like and do well in. It is another kind of challenge to prepare for external examinations that cover an entire curriculum, integrate one’s learning in the Theory of Knowledge course, and write an extended essay and perform community service, (p. 102)

alluding to IB as the more challenging of the two programs.

According to Kyburg, Hertberg-Davis, and Callahan (2007), minority IB students believed their teachers knew them on a personal level and were “confident that their teachers possess expert knowledge in their fields” (p. 205). They thought the TOK component of the IB curriculum “especially encourages students to challenge conventional ways of approaching problems or thinking about things, and the required extended essay is one area where students have more latitude to choose topics of personal interest” (p. 205).

There is much autonomy given to teachers in the IB program, allowing them freedom of choice in the types of activities and options for students. Numerous studies have been conducted which examined teachers’ choices and the factors affecting those choices, both generally and specifically in science education (Ackay & Yager, 2010; Aikenhead, 1984; Akinoglu, 2008; Burris, et. al, 2007; Crawford, 2007; Deemer, 2004; Henry, 1994; Ingram, Louis, & Schroeder, 2004; Jones & Carter, 2007; Putnam, 1984; Westerman, 1991). It is well documented that teachers’ choices impact the lives of their students (Coleman & Cross, 2001; Croft, 2003; Lindsey, 1980; Wright, et. al, 1997). Westerman (1991) studied how factors influence expert
and novice teachers differently. Henry (1994) reported informal student outcomes and teacher enjoyment as major factors affecting teachers’ decisions, while Deem (2004) focused upon school culture. Ingram et al. (2004) examined how the decisions teachers make are data driven because teachers look at the results on standardized assessments to make some of their decisions. Lunetta, Hofstein, and Clough (2007) noted teachers’ decisions are driven by learning outcomes which frequently are determined by high-stakes tests. Also, it was found that teachers’ decisions are most influenced by how they were taught and some find it hard to break this mold (Ackay & Yager, 2010; Blanchard et al., 2008 & 2010).

“Individual teachers have substantial leeway in implementing AP and IB courses. Therefore, the nature and quality of instruction may vary considerably from classroom to classroom” (Gollub et al., 2002, p. 10). Studies conducted to probe the relationship between teacher behavior and student learning and achievement found a definite relationship (Brophy, 1979; Burton, et al, 2002; Haycock, 1998; Schroeder et al. 2007; Wenglinsky, 2002; Wright, et al, 1997). Kyburg et al. (2007) listed two key factors which contributed to minority students’ academic growth. One of these was teachers providing “scaffolding to support and challenge students” (p. 173). This support included time spent with students before and after school, lunchtime discussion groups, and college visits subsidized by the school. “Differences in teacher effectiveness were found to be the dominant factor affecting student academic gain” (Wright et al., 1997, p. 66).

Inquiry as a curricular component, both inquiry teaching and inquiry by students, has been investigated extensively in science education as an important component of students’ learning (Ackay & Yager, 2010; Akinoglu, 2008; Blanchard 2008 & 2010; Crawford, 2007; Forbes & Davis 2010; Kang, Orgill & Crippen, 2008; Lebak & Tinsley, 2010; Wang & Lin,
2008). Fradd and Lee (1999) found that many science teachers have not embraced inquiry as a pedagogical approach due to the complexity of teaching in a nontraditional manner. Alozie, Moje, and Krajcik (2009) found that constraints such as time limited the use of inquiry in the classroom. Blanchard et al. (2010) found constraints imposed by standardized assessments limited inquiry, especially when curriculum supports were not in place. Beyer et al. (2009) showed little support for teachers choosing inquiry and suggested incorporating educative materials for teacher use in their curriculum as better than providing professional development for teachers to promote inquiry.

The standard for what is inquiry has come from Inquiry and the National Science Education Standards (NRC, 2000). It identifies classroom inquiry as having five essential components: (a) learner engages in scientifically oriented questions; (b) learner gives priority to evidence in responding to questions; (c) learner formulates explanations from evidence; (d) learner connects explanations to scientific knowledge; and (e) learner communicates and justifies explanations (NRC 2000). In practice there is a continuum of instructional approaches ranging from entirely teacher directed to completely open-ended inquiry (Blanchard et al., 2010).

**Purpose**

This study’s foci included the choices IB science teachers make for IA activities, IA resources, and IA categories. The relationship between teachers’ demographics and these choices was examined.

The following research questions were used to gather information on these foci:

**Research Question 1:** What curricular choices do IB science teachers make related to IA activities?
Research Question 2: What choices do IB science teachers make regarding the level of use for the different categories of IA?

Research Question 3: To what degree do IB science teachers’ courses taught, years of experience (total and IB), level of education, undergraduate major, graduate major, school population, and percentage of students enrolled in IB affect their IA choices?

Methodology

Sample

Fifty-three teachers who responded to the survey had attended either a Level 3 IB conference in Reston, Virginia or a round-table discussion meeting in Kansas City, Missouri. Participants from the Reston conference were initially contacted electronically by International Baccalaureate – North America (IBNA) with a letter introducing the study and asking for their participation. Surveys were e-mailed directly to the teachers who volunteered to participate. Participants from the Kansas City, Missouri round-table discussion were either given a survey on the day of the discussion or received an e-mail. All teachers in the sample were IB science teachers. This sample of teachers included 25 biology teachers, 18 chemistry teachers, and 10 physics teachers.

Design

A survey was selected as the best approach to quickly and easily reach many people in widely scattered areas (Van Dalen, 1966). Schaefer and Dillman (1998) stated that “the cost and speed advantages of e-mail make it ideal for a first mode of contact in surveys” (p. 379). Since the IB science teachers in this study were located throughout North America, ease of reaching many of them in a timely fashion was essential. Participants in this study were given the choice
as to whether they wanted the survey sent by regular mail or as an e-mail attachment. All 40 Reston participants preferred receiving and responding to their survey through e-mail. Eight (62%) of the Kansas City participants completed the survey at the roundtable discussion; the rest returned the survey electronically.

An initial survey was designed and then piloted with 12 individuals to determine whether the format and style of the survey were appropriate. Respondents made comments about improvements, areas where clarification was needed, or additions they would suggest. The survey was revised based upon suggestions from the pilot and a panel of science educators to provide validity.

This survey was designed to ascertain information from IB science (biology, chemistry, and physics) teachers related to their IB curriculum in the areas of resources for IA, areas of emphasis for IA, and types of IA activities. Items for the list of IA activities came from activities listed in various IBO publications including curriculum guides and the National Survey of Science and Mathematics Education (Weiss, Banilower, McMahon, & Smith, 2001). The 2006-2007 and 2007-2008 school years provided the data about these choices. During this time a major curriculum change occurred. This curriculum change involved renaming the categories by which students were assessed on their IA’s and changing the focus of the mark schemes to be focused on inquiry design, data collection and processing instead of the general planning A and B categories which existed before.

Science teachers recorded their frequency levels for the different IA categories. For the 2006-2007 school year choices for these categories included: Planning A, Planning B, Data Collection, Data Processing and Presentation, and Conclusion and Evaluation. Planning A and B included aspects of design including a research question, hypothesis, materials and procedure
written by the student. For the 2007-2008 school years these choices included: Design, Data Collection and Processing, and Conclusion and Evaluation. IB teachers are expected to do a minimum of two activities in each of these categories during the total implementation of the course but may do more. Categories for frequency levels identified on the survey were: Minimum (2 IA’s only), Rarely (3-6 IA’s), Sometimes (7-12 IA’s), and Often (more than 12 IA’s). The category Conclusion and Evaluation was the same for both 2006-2007 and 2007-2008 so teachers responded only once for this category.

The survey included a section which asked participants to record the number of times different activities on a list were used in their IA for one school year. They could also record additional activities not listed. Subsequently, a scale allowed teachers to identify the number of times they used particular resources from the list. Section II also requested teachers to identify the frequency they used the different categories of IA. The demographics section identified experience for both total teaching and IB teaching, undergraduate major, advanced degree, advanced degree major, type and size of school where they teach, percentage of students enrolled in IB at the school, and any further comments.

Surveys were e-mailed to IB science conference participants or given directly to roundtable attendees who agreed to participate in the study. In addition to the survey, a letter of introduction and suggested reply deadline were provided. Participants were given two weeks to return the survey. After those two weeks, a follow-up e-mail was sent to all non-respondents.

Data Analysis

Descriptive statistics were calculated for demographics: science course taught, total number of years teaching, number of years IB teaching experience, undergraduate major, highest earned degree, graduate major, total school population, and percent of students enrolled in IB.
Pearson’s product-moment correlations and linear regression values were computed as tests of statistical significance of the three research questions.

**Results**

**Demographics**

Demographic information was used to determine the factors which affected IB science teachers’ choices for curriculum and instruction. Twenty-five (47%) respondents taught biology, 18 (34%) taught chemistry, and 10 (19%) taught physics. The mean total years of teaching experience were 15.8 (SD = 15.8). Forty-four teachers (85%) held a master’s degree or higher. Forty-three (81.1%) teachers held an undergraduate major in a science field. Their graduate majors were in education for 26 respondents (50%). The mean value for the population of students in the schools where they taught was 1688.2 (SD = 663.04). The mean percentage for students enrolled in IB was 21.57% (SD = 22.74).

**Internal Assessment**

*Internal Assessment*

Table 1 summarizes the means and standard deviations for all teachers’ IA activity use. Hands-on activities and worksheets had means of 23.11 (SD = 19.10) and 22.73 (SD = 26.18) respectively. Recording or presenting data had a mean of 15.41 (SD = 16.83) and graphical analysis had a mean of 10.79 (SD = 10.69). The mean for graph development averaged 9.72 (SD = 9.84), while students’ design experiments and data logging had similar means, 4.17 (SD = 3.05) and 4.15 (SD = 6.07) respectively. The IA activities which had the lowest level of use were field trips and collaboration with professionals.
Table 1: Means and Standard Deviations for Times IA Activities Chosen by Sample Teachers (n = 52)

<table>
<thead>
<tr>
<th>IA Activities for 2007-2008</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database analysis</td>
<td>2.06</td>
<td>4.57</td>
</tr>
<tr>
<td>Data logging</td>
<td>4.15</td>
<td>6.07</td>
</tr>
<tr>
<td>Graphical analysis</td>
<td>10.79</td>
<td>10.69</td>
</tr>
<tr>
<td>Graph development</td>
<td>9.72</td>
<td>9.84</td>
</tr>
<tr>
<td>Simulations</td>
<td>3.30</td>
<td>3.66</td>
</tr>
<tr>
<td>Hands-on activities</td>
<td>23.11</td>
<td>19.10</td>
</tr>
<tr>
<td>Student written investigations</td>
<td>8.74</td>
<td>10.37</td>
</tr>
<tr>
<td>Participation in field work</td>
<td>1.64</td>
<td>3.84</td>
</tr>
<tr>
<td>Worksheets</td>
<td>22.73</td>
<td>26.18</td>
</tr>
<tr>
<td>Literature research</td>
<td>2.40</td>
<td>2.64</td>
</tr>
<tr>
<td>Model building</td>
<td>2.06</td>
<td>3.22</td>
</tr>
<tr>
<td>Group projects</td>
<td>4.09</td>
<td>5.26</td>
</tr>
<tr>
<td>Spreadsheet analysis on computer</td>
<td>1.28</td>
<td>2.00</td>
</tr>
<tr>
<td>Record or present data</td>
<td>15.41</td>
<td>16.83</td>
</tr>
<tr>
<td>Audio/visual presentations</td>
<td>5.56</td>
<td>13.91</td>
</tr>
<tr>
<td>Students design experiments</td>
<td>4.17</td>
<td>3.05</td>
</tr>
<tr>
<td>Collaboration with professionals</td>
<td>.43</td>
<td>1.15</td>
</tr>
<tr>
<td>Field trips</td>
<td>.90</td>
<td>1.13</td>
</tr>
</tbody>
</table>
The significant relationships listed in Table 2 for linear regression occurred when science course taught was the independent variable and the IA activities data logging, graphical analysis, graph development, participation in field work, literature research, and spreadsheet analysis on the computer were dependent variables. Significant relationships were also shown between years of IB teaching experience and collaboration with professionals. Graduate major as an independent variable showed a significant relationship with the IA activity record and present data.

**Table 2: Linear Regression Data IA Activities as the Dependent Variable and Demographics as the Independent Variables (n= 52)**

<table>
<thead>
<tr>
<th>Dependent Variable IA Activity</th>
<th>Independent Variable Demographic</th>
<th>R²</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data logging</td>
<td>Science course</td>
<td>.235</td>
<td>3.250</td>
<td>1.057</td>
<td>.403</td>
<td>.004</td>
</tr>
<tr>
<td>Graphical analysis</td>
<td></td>
<td>.100</td>
<td>-4.715</td>
<td>2.081</td>
<td>-.317</td>
<td>.028</td>
</tr>
<tr>
<td>Graph development</td>
<td></td>
<td>.124</td>
<td>-4.793</td>
<td>1.878</td>
<td>-.352</td>
<td>.014</td>
</tr>
<tr>
<td>Participation in field work</td>
<td></td>
<td>.103</td>
<td>-1.727</td>
<td>.750</td>
<td>-.322</td>
<td>.026</td>
</tr>
<tr>
<td>Literature research</td>
<td></td>
<td>.088</td>
<td>-.988</td>
<td>.470</td>
<td>-.296</td>
<td>.041</td>
</tr>
<tr>
<td>Spreadsheet analysis on a computer</td>
<td></td>
<td>.229</td>
<td>.841</td>
<td>.353</td>
<td>.313</td>
<td>.022</td>
</tr>
</tbody>
</table>
Table 3 shows categories for Data Collection (2001), Data Processing and Presentation (2001), Data Collection and Processing (2007) and Conclusion and Evaluation (2001 & 2007) were used at the level “Sometimes” indicating these categories were used 7-12 times for IA’s during 2007-2008 by most teachers. “Minimum” was the most frequently chosen level of use for Planning A (2001), Planning B (2001), and Design (2007), indicating these categories were used two times during the school year. The level “Never” was chosen by 12 teachers (22.6%) for the category, Design. This may be due to the fact that this category was new to the IB curriculum in 2007-2008.

Table 3: Frequency and Percentage of the IA Categories’ Levels Chosen From the 2001 & 2007 Curriculum Guides in 2007-2008 (n = 53)

<table>
<thead>
<tr>
<th>IA Category</th>
<th>Never</th>
<th></th>
<th>Minimum</th>
<th></th>
<th>Rarely</th>
<th></th>
<th>Sometimes</th>
<th></th>
<th>Often</th>
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<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
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<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
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<tr>
<td>2001</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning A</td>
<td>1</td>
<td>1.9</td>
<td>5</td>
<td>9.4</td>
<td>30</td>
<td>56.6</td>
<td>12</td>
<td>22.6</td>
<td>5</td>
<td>9.4</td>
</tr>
<tr>
<td>Planning B</td>
<td>1</td>
<td>1.9</td>
<td>5</td>
<td>9.4</td>
<td>30</td>
<td>56.6</td>
<td>13</td>
<td>24.5</td>
<td>2</td>
<td>7.5</td>
</tr>
<tr>
<td>Data Collection</td>
<td>4</td>
<td>7.5</td>
<td>2</td>
<td>3.8</td>
<td>4</td>
<td>7.5</td>
<td>16</td>
<td>30.2</td>
<td>27</td>
<td>50.9</td>
</tr>
<tr>
<td>Data Processing &amp;</td>
<td>4</td>
<td>7.5</td>
<td>2</td>
<td>3.8</td>
<td>5</td>
<td>9.4</td>
<td>17</td>
<td>32.1</td>
<td>25</td>
<td>47.2</td>
</tr>
<tr>
<td>Presentation</td>
<td></td>
<td></td>
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</tbody>
</table>
Pearson’s product-moment correlations were found between 2001 IA category Planning B with years of IB experience ($r = -0.290$) and 2001 IA category Data Collection with graduate major ($r = -0.280$). Regression analysis with IA categories as the dependent variable and demographics as the independent variable revealed no relationships (Table 4).

Table 4: Pearson’s Product-Moment Correlation Coefficient (r) Different IA Categories and Demographics ($n = 53, n^a = 48$)
## Data Collection

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Data Processing</td>
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<tr>
<td>Planning A</td>
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<tr>
<td>Planning B</td>
<td></td>
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<td></td>
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<tr>
<td>Design</td>
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## Data Processing and Presentation

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Data Collection</td>
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<tr>
<td>Data Collection &amp; Process</td>
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<td></td>
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<tr>
<td>Conclusion &amp; Evaluation</td>
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</tbody>
</table>

*p < .05

## Conclusions

There was variety related to the IA activities that IB science teachers used in instruction. The predominant activities used were hands-on activities and worksheets. Several individual teachers reported that they used these IA activities at least 100 times during the year. Only two of the activities were used very little on the average: collaboration with professionals and field trips. Budget constraints experienced by schools in recent years may help to explain why these activities are done less frequently when considering their effectiveness for increased student learning.

Inquiry is not a great emphasis among IB science teachers. The only components of inquiry being utilized were found in the IA categories Planning A, Planning B, and Design. The primary levels of uses for these categories were “rarely” or “sometimes.” There is some
emphasis among IB science teachers on Data Collection and Processing, which are important aspects of inquiry listed in NSTA’s inquiry position statement (NSTA, 2004).

Teachers who cited reasons related to experience and background such as “I was successful with this last year,” supported Aikenhead’s (1984) conclusion that teachers may draw upon instructional resources such as last year’s lesson plans and their own experiences to make “holistic” decisions which integrated science with practical knowledge. Similarly, Henry (1994) noted that informal student outcomes, teacher enjoyment, and teacher compatibility were some of the most prevalent reasons teachers utilize for making curricular choices. This supports Doyle and Ponder (1977-78) who noted that teachers base their decision making on practicality which is affected by three criteria: instrumentality, congruence, and cost.

Hands-on activities as the most frequently used IA activity supports Van den Berg, Katu, and Lunetta (1994), who proposed that when teaching circuits to high school students, hands-on activities were effective for modeling what was involved in circuits. They also found hands-on activities alone were ineffective in teaching all of the scientific relationships required for a complete understanding of circuits. It is important to note this study found that simulations had one of the lowest usage means for IA activities.

Lunetta (1998) proposed that the number of hands-on activities should not be the predominant factor affecting science learning. He considered it to be better for students to do a few “authentic” activities than to do many which are superficial. He recommends to encourage students in minds-on as well as hands-on activities, which is influenced by factors such as cost and safety (Lunetta et al., 2007).

Worksheets were the second-most used activity for IA’s. This could mean IB science teachers understand and utilize the ideas suggested by NCR (2006) that when the goal for
instruction was student mastery of subject matter, other forms of science instruction could be just as effective as laboratory activities. Weiss, Pasley, Smith, Banilower, and Heck (2003) in their *Inside the Classroom* proposed that the “quality of lessons did not depend on whether the teacher used a ‘reform-oriented’ approach or a traditional approach. Some lessons judged to be effective were traditional in nature, using lectures and worksheets” (p. 24).

Since worksheets were identified as one of the most prominent IA activities, this seems to indicate IB teachers are limiting authentic laboratory experiences (Hawkes, 2004). Activities like students’ design experiments and participation in field work were considerably lower in frequency than worksheets. Although data collection and data processing were some of the most frequently used categories for IA’s, the design category was significantly lower. It is not known how students are directed to collect data, but it may be after the teacher directs students to collect certain data or ask students to complete “cookbook” laboratories. If so, this does not allow students “to identify and ask appropriate questions that can be answered through scientific investigations” (NSTA, 2004, p. 2) or become involved in laboratory processes and developing safe and conscientious laboratory practices (NSTA, 2007).

Hofstein and Lunetta (2004) cautioned that although it is important to use laboratory activities in instruction, inquiry alone is not sufficient to assure students achieve a complete understanding of science. Coulter (1966) found that inductive laboratory approaches were not only just as effective as a deductive approach for student instruction and success, but they also were better suited to teaching cause and effect relationships and making judgments after examining evidence. Gardiner and Farregher (1997) found that even when the laboratory activities performed by students were qualitative and confirmatory and less than those required by the course outline, students still were able to answer laboratory-based questions on exams.
Inquiry is not a major emphasis among the IB science teachers participating in this study even though the IB mission states it is important. One possible reason for this may be that IB science teachers do not have the pedagogical content knowledge necessary to be comfortable choosing to include more inquiry in their curriculum, or they feel that inquiry will take time away from preparing for the IB examinations (Wood, 2002). Blanchard et al. (2010) state, “Findings suggest that inquiry methods and high-stakes test performance are not incompatible” (p. 609).

Currently this issue is dealt with as IBO modifies students’ scores on IA’s and encourages increased inquiry. This is not enough. If teachers are uncomfortable and unprepared to incorporate inquiry into their curriculum and instruction, then credentials for IB teachers may need to include that teachers have the ability, desire, or support to use inquiry. Professional development regarding what inquiry is and how to use it can be provided for IB teachers or materials be provided which help teachers learn how to incorporate inquiry into their instructional practices (Beyer et al., 2009; Wood, 2002).

Bibliography


