Exploring the Learning Benefits and Outcomes of the IB Extended Essay in Preparing Students for University Studies in Canada

Phase I Research Report to the IBO

August 2013

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OVERVIEW

This report is part of a two-phase International Baccalaureate (IB) commissioned research project exploring the impact of the Diploma Programme (DP) extended essay (EE) experience on student university success. The objectives of this research project are: 1) To gather evidence of the contributions of the EE to McGill undergraduate students' value of inquiry instruction, inquiry instruction self-efficacy and the importance they assign to inquiry strategies as ranked by experts. 2) To describe and compare IB and non IB undergraduate students' perceptions of the association between their EE DP experience and their university academic course work experiences, and choices of inquiry opportunities at university. 3) To determine the extent to which variation in the overall value assigned to inquiry instruction can be predicted by IB schooling, non IB schooling, epistemological beliefs, knowledge of science, inquiry self-efficacy, and approach to learning. To accomplish these objectives we have employed a two-phase research design. The first phase, the subject of this report, draws on ongoing research at McGill University on inquiry. The second phase, to be addressed in a forthcoming report, merges the quantitative findings discussed in this report with a qualitative analysis of student interviews.

Background for Phase I

Inquiry, as an instructional approach, has been an especially significant component of recent educational reform efforts (*Inquiry and the National Science Education Standards: A Guide for Teaching and Learning*, 2000; *National Science Education Standards*, 1996). The National Science Education Standards (NSES) define inquiry as:

> A multifaceted activity where students: make observations; pose questions; research in textbooks and other reference materials what is already known; plan and implement investigations; use evidence to explain questions; use tools to gather, collect, and interpret data; propose answers, questions, and predications; and communicate findings (p. 22).

However this standard may lead many teachers to conclude that inquiry is too difficult to do and thus do not attempt inquiry at all (Brown, Abell, Demir, & Schmidt, 2006; Keys & Bryan, 2001; Wee, Shepardson, Fast, & Harbor, 2007). Keys & Bryan (2001) posit that, "multiple modes of inquiry teaching and learning will invite teachers to engage in participating in inquiry in ways that match their own beliefs and teaching styles" (p. 632), a view that is supported by Blanchard, Southerland, & Granger (2009). In addition, the best choice of inquiry instruction can depend on many variables, including goals of the curriculum, student past experience with inquiry, classroom context, and school resources (Settlage, 2007; Songer, Lee, & McDonald, 2003). Because there are multiple ways to encourage inquiry in the classroom (Bybee, 2000; Martin-Hansen, 2002; Tafoya, Sunal, & Knecht, 1980), inquiry may be best represented as a collection of approaches that employ aspects of inquiry in the NSES definition (Brown, et al., 2006; Furtak, 2006; *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning*, 2000; Lee,

Buxton, Lewis, & LeRoy, 2006). Other research has reported evidence that the nature of inquiry may be domain specific. For example, the methodology used to inquire in the sciences is not the same as in mathematics, history, or the arts. While the IB does not provide an introduction to methods of research as a formal course of the IB DP, the theory of knowledge course (one required component of the IB DP) affords an introduction to epistemology and philosophical issues. This has potential implications for the extent to which inquiry-learning experiences afforded through the IB DP extended essay will have the same or equally positive outcomes for students majoring in different degrees at university such as education compared to the sciences.

The 1996 National Research Council (NRC) definition of inquiry appears to match the IB DP EE guidelines provided to students as preparation for the EE, as evidenced by school documents provided to the researcher and IB documentation of the EE guidelines (IBO, 2007). The IB offers programs for elementary (Primary Years Program, PYP), middle years (Middle Years Programme, MYP), and secondary education (Diploma Programme, DP). Research studies comparing DP graduates to A-level applicants in UK universities shows that on a variety of criteria the DP trained population obtains more positive outcomes (HESA, 2011). These are powerful findings. There is considerable research that does support the claim that positive learning outcomes are associated with approaches that describe themselves as inquiry based (M. W. Aulls & Shore, 2008). Nevertheless, there are researchers who challenge the warrant of any kind of inquiry instruction to promote valued learning outcomes in education (Mayer, 2004) or in the sciences (Kirschner, Sweller, & Clark, 2006).

The International Baccalaureate Organization has from its origins combined inquiry teaching and learning, with a focus on international education, at every level of its curriculum, from elementary through secondary education. In IB *Research Notes* volume 3, issue 1, Bechtel and Waterson (2003) argue that stronger bridges are needed between teacher education and educational research in the 21st century. They state:

> The PYP and MYP programmes of the IBO for example are both constructivist in approach by offering frameworks where students are encouraged to construct their own meaning. The "approaches to learning" and the "units of inquiry" of these programmes recognize that modern curriculum aimed at enabling young people to enter a world characterized by an abundance of information, and the need for critical, creative meaning themselves and, critically, to evaluate and make judgments about the validity of this understanding (p. 2-3).

These authors also recognize that "Empowering students to take greater control over their own learning requires teachers to make a paradigm shift in how they operate" (p. 3). They recommend that teacher education training at the university and professional development training based on educational research findings is most likely to offer a bridge to bring greater congruency in learning for the student.

Previous research informing this study

Our ongoing research on inquiry has been focused on understanding educators' conceptions of inquiry and its relationship to the instruction they have received as well as the classroom instruction they plan, enact and reflect upon. For example, currently we are focusing on the validation of instruments to assess student views of the importance of inquiry instruction and how confident students and teachers feel about the task demands of specific components of inquiry instruction and inquiry learning (Aulls & Ibrahim, 2012; Shore, Chichekian, Syer, Aulls, & Frederiksen, 2012). We have also written books reviewing the relevant theory and research on inquiry teaching and learning in classrooms and proposing those practices that research seems to support (Aulls & Shore, 2008). We have written a book presenting a series of case studies focused on the teaching of history, science and mathematics using an inquiry approach to instruction (Aulls & Ibrahim, 2012; Manconi, Aulls, & Shore, 2008; Redden, Simon, & Aulls, 2007; Shore, Aulls, & Delcourt, 2008). We have done action research on the influences of using an inquiry based approach to teach educational psychology courses to pre-service teachers and to teach physics to education majors, engineering majors and science majors (Aulls et al., 2007; Kalman & Aulls, 2003; Kalman, Aulls, Rohar, & Godley, 2008). We have developed several authentic measures of the extent to which inquiry instruction is valued, what aspects of the planning, enactment and reflection on inquiry instruction are considered to be most and least important from the teacher and the students perspective, and the inquiry instruction self-efficacy of educators (Shore, Walker, Ritchie, LaBanca, & Aulls, 2009). Our previous work on inquiry provides a qualitative description of how inquiry based and non-inquiry based instruction differs, and includes the triangulation of direct observation of classroom instruction, interviews with the professor about the extent to which they perceive their instruction to be inquiry-oriented, an analysis of their written course outlines, and the perceptions of the typical student in their course of what effective instruction entails.

Along with the qualitative study just described, we have collected data on students who are education majors and students who are science majors at McGill and two other universities. Our research focuses on the relationship between the students epistemological knowledge, knowledge of the nature of science, approaches to learning and studying, inquiry self-efficacy, value of inquiry instruction, conceptions of inquiry, perceptions of effective instruction and its equivalence to inquiry based effective instruction, and understanding of the relative importance of strategies of inquiry. Our objective is to identify what factors distinguish pre-service teachers who place a very high value on the features of inquiry instruction supported by educational research and those who place significantly less value on them. We are currently analyzing this data set, and several doctoral theses will be forthcoming in the next year. This set of data also includes IB schooled undergraduates that are included as the sample for the research project commissioned by the IB and the subject of the following report. This phase 1 research report is informed by research questions 2 through 8 listed below. Research questions 1 and 9-11 will be addressed in phase 2 of the project.

2. How do IB DP graduates at McGill compare to non-IB DP graduates in terms of inquiry self-efficacy, inquiry values, epistemic beliefs, approach to learning, and

beliefs about the nature of science?
3. What proportion of the variability in the importance attributed to inquiry strategies ranked as important by experts, is accounted for by IB schooled and non-IB schooled undergraduates' inquiry self-efficacy, epistemic beliefs, approach to learning, and beliefs about the nature of science?
4. What variables best account for membership in IB and non-IB groups that assign a high importance to inquiry instruction and learning?
5. Is there a significant difference between epistemic beliefs of pre-service teachers graduating from IB DP schooling compared to non-IB pre-service teachers?
6. Is there a significant difference between the learning approaches of pre-service teachers graduating from IB DP schooling compared to non-IB pre-service teachers?
7. Is there a significant difference between the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ) Scores of IB and non-IB undergraduate pre-service teachers?
8. Is there a significant difference between the inquiry self-efficacy of pre-service teachers graduating from IB DP schooling compared to each other and to non-IB pre-service teachers?

Relevance for the IB

A major outcome at each level of the IB curriculum (PYP, MYP, and DP) is to actively engage students in learning content with increasingly greater responsibility for how to inquire in a systematic and scholarly manner over an extended period of time. In fact, at the PYP, MYP, and DP curriculum levels, becoming "an inquirer" is a central outcome of instruction (IBO, 2008). At the DP level, the extended essay (EE) represents the continued emphasis on learning content through inquiry and increasing expertise in learning how to inquire.

However, the emphasis on inquiry and becoming an inquirer may not be the same in all IB schools. For example, The Hong Kong Institute for Education (Hallinger, Walker, & Lee, 2010) reported, on the basis of a survey of 235 IB coordinators and 5 full continuum DP schools in the Asia-Pacific Region, that "…increased emphasis on inquiry-based learning in the DP is needed and a wider range of internal assessment tools (p. 7)." Research results also suggest that teachers' views or conceptions of inquiry affect their use of inquiry (Kang & Wallace, 2005). For example, a teacher who believes that students are engaged in inquiry when doing a hands-on "cookbook" laboratory may not realize that inquiry can be much more than this. In the Hong Kong study, one of the factors that seemed to be associated to less emphasis on inquiry instruction was an increased emphasis on testing students. This raises the possibility that the extended essay in the Asia-Pacific Region may not have the desired impact on student academic achievement in university as an undergraduate. In North American schools, there is also a heavy emphasis on testing as part of formal education. This emphasis may also infringe upon North American IB student perceptions of the value of inquiry in their schooling experiences and their opportunity to learn how to inquire because of more emphasis being given to the heavy course work load and preparing for paper and pencil testing in the DP. Moreover, researchers have theorized (Spector & Gibson, 1991) that when a heavy emphasis is given to testing it is difficult to

build the trust, risk taking and motivation necessary to engage students in inquiry units, projects or "extended essays" that are inherently high in risk and ambiguity.

Reviews of the success of experienced and beginning teachers in planning and enacting inquiry-based instruction suggest that it is very challenging regardless of teaching experience (Windschitl, 2004). Moreover, Windschitl (2003) found that 100% of the students in his science courses for pre-service teachers who chose to take an inquiry instructional approach during student teaching were those who had been actively involved in high school and/or college in research opportunities. Thus, IB schooling may make the difference between those pre-service teachers who do and do not choose to take an inquiry approach as beginning teachers.

The research objective identified by the IB specifies that research projects should "…explore the learning benefits and outcomes attributed to the IB EE in terms of knowledge skills, abilities, engagement and other aspects that prepare students for university studies (p. 1)." We are especially interested in IB students who are seeking a teaching degree, so in addition to examining a combined group of Science and Education majors, this study also compares Education majors separately. Our interest stems from the research literature cited above which indicates that inquiry instruction is difficult to accomplish for the beginning teacher and many students who are positive about an inquiry approach to instruction feel that pre-service teacher training does not sufficiently prepare them to attempt to carry out this approach during student teaching or as a first year teacher (Windschitl, 2002, 2003, 2004; Windschitl, Thompson, & Braaten, 2008).

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EXECUTIVE SUMMARY

Rationale

There may be a relationship between the extended essay learning experience and outcomes that have effects on IB undergraduates' epistemic beliefs, approach to learning, and value of the importance of various inquiry demands and inquiry self-efficacy.

Design

This study uses a quasi-experimental post-test design and regression analysis. Multiple dependent variables are used to compare an available sample of undergraduate students who did and did not earn an International Baccalaureate Diploma. The university records office identified IB students as those who participated in an IB Diploma Programme and earned the IB Diploma. Regression analysis is done on the entire sample to determine what variables best account for the variability of students overall rating of the importance of inquiry instruction and learning. Logistic regression is used to determine which variables can account for undergraduate students' membership in the group assigning the highest value to the importance of the demands of inquiry instruction and learning. The same five instruments were used in all the analyses:
The McGill Inquiry Self-efficacy Questionnaire (SDEIQ), the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ), Schommer's Epistemological Beliefs Questionnaire (SEBQ), the Learning Processes Questionnaire (LPQ) and the Views of Nature of Science form C (VNOS-C) Questionnaire (full descriptions are available in the Appendix).

Methodology

A sample of convenience is taken of 302 undergraduates. Sample sizes vary with each research question because not all participants completed all the surveys. Data collection was done face to face and on line. ANOVA, MANOVA, linear multiple regression, logistic regression analysis and Chi Square statistics were used.

IB graduates compared to non-IB graduates. A series of ANOVA and MANOVA were run using SPSS 20 on survey data from Science and Education students studying at McGill University. Registration data was used to group the students in two categories: 143 IB graduates (from Quebec and abroad) and 80 non-IB graduates, and a further, unspecified group of 33, including mature students. The five surveys used were the McGill Inquiry Self-efficacy Questionnaire (SDEIQ), the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ), Schommer's Epistemological Beliefs Questionnaire (SEBQ), the Learning Processes Questionnaire (LPQ) and the Views of Nature of Science form C Questionnaire (VNOS-C). An ANOVA was run for the two groups on the total scores for both the SDEIQ and the MSDIQ. Subsequent MANOVA were also run on the factor scores for each of the measures.

IB pre-service teachers compared to non-IB pre-service teachers. A series of ANOVA and MANOVA were run using SPSS 20 on survey data from Education students studying at McGill University. A sample of 223 Education majors were divided into two groups of either IB graduates or non-IB graduates. Registration data was used to group the students in two categories: 145 IB graduates (from Quebec and abroad) and 47 non-IB graduates, and a further, unspecified group of 31, including mature students. The five surveys used were the McGill Inquiry Self-efficacy Questionnaire (SDEIQ), the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ), Schommer's Epistemological Beliefs Questionnaire (SEBQ), the Learning Processes Questionnaire (LPQ) and the Views of Nature of Science form C Questionnaire (VNOS-C). An ANOVA was run for the two groups on the total scores for both the SDEIQ and MSDIQ. Subsequent MANOVA were also run on the factor scores for each of the measures.

Results

IB graduates compared to non-IB graduates

No significant results were obtained for the SDEIQ. Four significant results were obtained for the MSDIQ factors: factor 2. Generative Inquiry ($F(1, 90) = 4.556$, $p = .036$, $\eta^2 = .048$), factor 6. Co-Construction of Inquiry ($F(1, 90) = 4.523$, $p = .036$, $\eta^2 = .048$), factor 8. Student Inquiry Communication Strategies ($F(1, 90) = 4.473$, $p = .037$, $\eta^2 = .047$), and factor 13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences ($F(1, 90) = 6.898$, $p = .010$, $\eta^2 = .071$). No significant result was obtained for the SEBQ ANOVA. The SEBQ MANOVA was significant ($\Lambda = .744$, $F(12, 109) = 3.131$, $p = .001$, $\eta^2 = .256$). Between-subject effects below showed that factors 4, 5, and 11 present significant differences (4. Knowledge is Certain $F(1, 120) = 3.963$, $p = .049$, $\eta^2 = .032$), 5. Depend on Authority ($F(1, 120) = 4.231$, $p = .042$, $\eta^2 = .034$), 11. Learn Quick ($F(1, 120) = 13.039$, $p = .000$, $\eta^2 = .098$).) The LPQ ANOVA did not reveal a significant difference for total score. The LPQ MANOVA revealed a significant multivariate effect ($\Lambda = .925$, $F(6, 105) = 1.418$, $p = .214$, $\eta^2 = .075$). Between-subject effects were significant for 1. Surface Motivation $F(1, 112) = 4.542$, $p = .035$, $\eta^2 = .040$). No significant results were found for the VNOS-C.

IB pre-service teachers compared to non-IB pre-service teachers

No significant results were obtained for the SDEIQ. One significant result was obtained for the MSDIQ factor 6. Co-construction of inquiry ($F(1, 91) = 6.736$, $p = .012$, $\eta^2 = .121$). No significant result was obtained for the SEBQ ANOVA. The SEBQ MANOVA was ($\Lambda = .857$, $F(12, 58) = 4.142$, $p = .000$, $\eta^2 = .461$). Between-subject effects below showed that factors 1, 3, and 12 present significant differences (1. Seek Single Answers $F(1, 69) = 4.420$, $p = .017$, $\eta^2 = .121$), 3. Avoid Ambiguity ($F(1, 69) = 6.035$, $p = .017$, $\eta^2 = .080$), 12. Concentrated Effort ($F(1, 69) = 14.577$, $p = .000$, $\eta^2 = .174$).) The LPQ ANOVA did not reveal a significant difference for total score. The LPQ MANOVA did not reveal a significant multivariate effect. Between-subject effects were significant for 1. Surface Motivation $F(1, 59) = 4.146$, $p = .046$, $\eta^2 = .066$) and 4. Deep Approach $F(1, 59) = 6.437$, $p = .014$, $\eta^2 = .098$). No significant results

were found for the VNOS-C.

Discussion

Quasi-Experimental Group Comparisons

The overall pattern of results indicates that when undergraduates in Science and Education are combined and compared to non-IB undergraduates, there are many significant differences favoring the IB trained undergraduate students. Specifically, IB trained students have more sophisticated epistemic beliefs, moderate surface motives associated with their approach to learning, and higher ratings of aspects of inquiry learning that represent self-regulation of the inquiry process. When only Education students are considered, the evidence suggests IB undergraduates still have higher ratings of importance assigned to the reflective and self-regulatory dimensions of inquiry learning than non-IB students. But there is a lack of alignment between their motives and approaches to learning. On the positive side, the Education IB undergraduates who have high Inquiry Self-efficacy scores also highly rate the importance of inquiry instruction and learning. These students also rate the importance of the teacher and student co-construction of inquiry higher than non-IB students. This rating may be associated with other components of the IB programme or could indicate they perceive the EE as a shared endeavor between the teacher and student. However, it also may suggest they are too dependent on the teacher to accomplish the demands of inquiry instruction and learning, which underlie the completion of the extended essay as well as participation in undergraduate courses that are inquiry based. Follow-up interviews in phase II should help clarify how Education IB graduates retro-spectively describe the co-construction of the extended essay as well as undergraduate courses that have placed demands like the EE on coursework, thesis writing or participation in a funded research project.

The MSDIQ measures student ratings of the importance of various demands of inquiry instruction and learning. The MSDIQ is comprised of three subscales representing three dimensions of the inquiry process: planning, enactment, and reflection. The items on the MSDIQ can be organized into 14 factors (six for planning, six for enactment, and two for reflection). These 14 factors were consistent with the research process skills and strategies included in definitions of inquiry instruction in the literature (Shore, Chichekian, Syer, Aulls, & Frederiksen, 2012). Significant differences were found between IB and non-IB students for the *Student Inquiry Communication Strategies;* these are foundational conditions needed 1) to participate in inquiry instruction and inquiry learning in school and 2) for student Reflection Strategies which lead to the ability to self-regulate inquiry learning both with assistance and alone. The factor scores, when translated into a 10-point Likert scale for rating the demands of inquiry instruction and learning, suggest that differences between IB and non-IB undergraduates is on inquiry demands that are considered as somewhat important by IB students and significantly less important to non-IB students. IB and non-IB students tend to rate basic Entry Level Inquiry Strategies similarly as well as the Student Directed Inquiry Strategies (both do not require meta cognitive strategic thinking). Since college undergraduates may be expected to be in the

stage of awareness that allows them to independently use their knowledge of inquiry strategies, the non-IB students appear to be considerably behind the IB students whose ratings suggest that they are beginning to be aware of the importance of how to reflect on inquiry learning strategies as well as their experiences of doing inquiry. Qualitative interviews with students are necessary to further confirm the validity of this interpretation from the students' perspectives.

Epistemic beliefs were included as variables in this study since they have been shown to influence comprehension and other variables relevant to success at inquiry (Phan, 2008; Schommer, 1990; Schommer-Aikins & Easter, 2008). Previous research has also shown that epistemic beliefs about the nature of knowledge and knowledge use among undergraduates is relatively stable and only shifts slowly over a period of four years (Baxter Magolda, 2004; Cano, 2005; Hofer & Pintrich, 1997; King & Kitchener, 2004; Perry & Harvard University. Bureau of Study, 1970; Zeegers, 2004; Zimmerman, 1998). Thus, when we compare the non-IB and the IB undergraduates, we may hypothesize that the engagement in inquiry instruction and inquiry as a process in elementary and secondary school is associated with the epistemic beliefs held upon entry into university and that a number of years of further formal education are necessary to change their entry level beliefs. Prior research suggests that epistemic beliefs may influence variables making up learning (Bråten & Strømsø, 2005; Chan, 2000; Dahl, Bals, & Turi, 2005; Ravindran, Greene, & Debacker, 2005; Schommer-Aikins & Easter, 2008). Our results from the Schommer-Atkin Epistemic Beliefs Questionnaire (S-AEBQ) show that the non-IB students have three higher mean Likert scores than IB students. Specifically, they hold a stronger belief that knowledge is certain, that the legitimate source of knowledge is an authority, and that learning should be quick and easy rather than gradual and effortful. However, both groups have ratings below 4 and 5 on the 10-point scale and therefore both groups hold moderate to limited convictions about these beliefs. Since the non-IB students hold moderately strong beliefs on all three categories of epistemic beliefs, it would appear that IB schooling may reduce the strength of mistaken beliefs about knowledge that are not supported by philosophers.

Many investigators in North America, Europe, Australia and China have reported studies where they have used the LPQ to characterize the approach to learning utilized by secondary undergraduate students. Two categories of learning approaches have been repeatedly identified in all studies (Biggs, 1987a; Biggs, 1988; Burnett & Dart, 2000; Christensen, Massey, & Isaacs, 1991; Hattie & Watkins, 1981; Kember & Gow, 1990; O'Neil & Child, 1984; Renshaw & Volet, 1995; Volet, Renshaw, & Tietzel, 1994; Watkins & Akande, 1992; Watkins & Hattie, 1985; Watkins & Murphy, 1994). One approach is called a Surface Approach to learning and is held by students who view learning as primarily memorization of information. The other approach is called a Deep Approach to learning in which the goal of learning is to understand and not only remember information. Each of these factors includes a motive for learning that is considered surface or deep and is part of each factor's overall approach to learning. The deep approach begins with understanding and entails forms of higher order thinking other than memorization.

The IB and non-IB students significantly differed in the emphasis given to Surface

Motivation. The average IB student had a lower surface motivation score than the average non-IB student. Meaning, the average IB student is less likely to view learning as primarily memorization of information. The IB and non-IB groups were not significantly different in their deep approach or deep motivation strategies. These results suggest that more non-IB students than IB students are conflicted in their alignment of motives and approaches to learning. If you hold surface motives for learning but believe you take a deep approach to learning then you are not aware that *what you say you do* and *what you actually intend to do* are not the same. In short, another way of looking at the results is that IB students have better alignment between their motives and approach to learning.

In summary, the IB students are not only significantly different from the non-IB students in their ratings of the importance of inquiry strategies but also on their epistemic beliefs and approach to learning. It might well be argued that epistemic beliefs and approach to learning precede rather than follow inquiry instruction and learning, but it is also possible that they interact with each other. In either case, these results affirm that the academic demands of inquiry that students perceive as important are correlated with the nature and strength of their epistemic beliefs and their approach to learning. Neither undergraduate students' inquiry self-efficacy nor beliefs about the nature of science (as a multivariate set of variables or a complex unitary state) was significantly different when IB and non-IB groups were compared.

Regression Results

In order to consider a different criteria for comparing IB and non-IB groups of undergraduate students and to determine what variables could best account for their views of the important demands of inquiry instruction and learning, we hypothesized that IB undergraduate students would perceive more demands of inquiry to be very important compared to non-IB undergraduates because of their extensive participation in extended essay writing and inquiry-based learning experiences in the IB programme. The results of both the multiple regression and the logistic regression analyses offer support for this hypothesis. However, each analysis had separate goals and offered different insights into the relationships between the independent predictors accounting for the variability in the dependent variables.

The linear regression analysis results show that the overall approach to learning score and the views on the nature of science score account for a significant proportion of the variability in IB and non-IB students overall value of inquiry instruction and learning. This may be interpreted as excluding epistemic beliefs as a predictor of what demands undergraduates rate as most important. Thus, it implies that students with a high surface motive and approach to learning or a student who is high in one but low in the other may participate in the EE process in such a manner that is related to the approach the student takes. The VNOS-C results suggest that knowledge of science counts in the view students come to hold about inquiry instruction and learning. However, it explains far less variance in value of inquiry instruction and learning than the LPQ measure of approach to learning.

The logistic regression analysis attempts to analyze membership in the group of students who value inquiry and those who do not. For the average IB student, inquiry self-efficacy was a significant predictor of the overall importance rating assigned to inquiry task demands by IB graduates but not by non-IB graduates. For non-IB students, epistemic beliefs significantly predict the importance assigned to inquiry tasks. These results show that IB undergraduates accepted at a leading undergraduate university in North America demonstrate a sufficiently high and positive relationship between their self-efficacy as an inquirer and many of the complex social-cognitive demands underlying EE. For non-IB students whose membership is in the high inquiry-valuing group, it is their epistemic beliefs that matter in explaining the value they assign to inquiry instruction and learning. As stated earlier, previous research shows that epistemic beliefs are related to the frequency, quality and use of strategies entailed in inquiry as well as other tasks. The IB group appears to have benefited from participating in IB schooling, which could be what strengthened their inquiry self-efficacy and, in turn, their value of inquiry instruction and learning. Their epistemic beliefs no longer account for the high valuing of inquiry instruction and learning. Moreover, earlier MANOVA comparisons of IB and non-IB epistemic beliefs offer evidence that the IB students have more sophisticated beliefs than the non-IB students.

Educational Implications of the Overall Pattern of Results

The extended essay appears to follow the same fundamental guidelines in all IB Diploma institutions. A cursory review of several published guidelines ("The Extended Essay," 2010; "My Champlain, my college: International Baccalaureate, 2010-2011, Enriched Science Option," 2010) for participating in the EE include: 1) the formative and summative assessment opportunities in terms of the acceptable kinds of non-narrative inquiries in the sciences, social studies, humanities and the arts and the scoring of EE products by experts outside the IB DP institution that the student is attending; 2) materials developed to support IB students in accomplishing a plan for carrying out the EE as a form of inquiry including the schedule of events that structure the process; and 3) a description of the underlying thinking process to be engaged such as argument structure, series of experiments and writing of the results and their analysis, elements such as graphs; and guidelines for the writing style, cohesion and coherence markers to self-regulate the communicative dimensions of inquiry literacy. These guidelines appear to be very useful for the IB student in preparing a plan for engaging in the EE and for assuring similar timing and structure for a more knowledgeable adult to act in varied roles to support the student's thinking within a discipline-specific inquiry. But from a learning perspective, the supervisor is crucial to help the IB student develop the cognitive skills to self-regulate the complex of inquiry strategies during the two years taken to complete the EE. Without a mentor, many students might not finish the EE, might not accomplish an acceptable product and/or might not truly change their understanding of the inquiry process and ultimately more deeply understand their self-chosen topic or issue. Self-regulation of knowledge as a strategy is the final step of having internalized a cognitive strategy so it can be used with increasing ease and success when its warranted and further refined (Zimmerman, 2002).

The data from this study show that IB and non-IB students are different in what they view as important to the Foundational Strategies and the Reflection factors rated on the MSDIQ. Moreover, IB students are far closer to what experts view as the planning and cognitive reflective process entailed in inquiry as a process. However, the data also show that IB and non-IB students are not significantly different in their ratings of the importance of the many student-directed strategies needed to enact inquiry without assistance. In theory they should be. This result needs to be explained. It seems logical based on the results of this study that it may be highly probable that many IB graduates begin undergraduate studies without internalizing many valuable inquiry strategies to the level at which they can recognize their importance to learning how to inquire and to which they can self-regulate in a deliberate manner. Instead, like the non-IB students, they may receive little training in strategies from the MSDIQ (Table 1).

All the strategies in Table 1 could be largely modeled, facilitated and/or directly taught by the supervisor when the student really does not internalize how to do the thinking strategies that enable skills like "finds patterns in the data."

In Phase II interviews will be designed to determine the students' views of their lived experience in accomplishing the EE and its correspondence to inquiry.

Table 1

Selected strategies from the McGill Strategic Demands of Inquiry Questionnaire

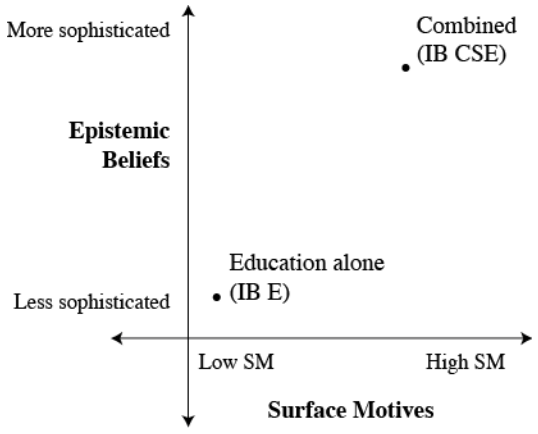
8 Skills for Collecting Data and Analyzing Data	The student identifies where to obtain data, records data, classifies data, finds patterns in data, understands hidden meanings in data, verifies data or information, and records methods, results, and conclusions. The student is aware of how the inquiry event affects one personally.
9 Defining the Problem Space in Terms of Data Characteristics	The student restates or reformats the problem, develops expectations of what will happen next, offers hypotheses about outcomes, makes careful observations, identifies where to obtain data, and recognizes hidden meanings in data.
10 Social Context of Solving the Problem	The student searches for resources beyond textbooks, seeks different viewpoints, tests ideas and hypotheses, compares and contrasts data with someone else's, anticipates and responds to arguments in opposition to one's view, uses vocabulary appropriate to the audience and topic, and accepts that more than one solution might be appropriate.
12 Expanding the Data or Information Search	The student searches for resources beyond textbooks, searches the Internet and World Wide Web, and separates relevant from irrelevant information.

The Reflection strategies of the MSDIQ appear to be highly valued by both IB Education and Science students. Along with the invaluable experience of undertaking and completing an extended essay, the faculties of Science and Education benefit from the IB curriculum because it provides students with the knowledge and experience to become aware of the importance of these strategies. Both offer building blocks for undergraduate students to be successful in research methods courses and may even motivate them to do an undergraduate honors thesis by increasing their self-efficacy as an inquirer.

Finally, the Education undergraduate students' results offer several implications for future consideration. The Education student with an IB diploma (E) differed from the combined Science undergraduates and Education undergraduates (IB CSE) who received an IB Diploma. The E group was less sophisticated in their epistemic beliefs than the non-IB while the CSE were more sophisticated than non-IB and the E group. The IB E had a lower Surface Motive than the IB CSE student (see Figure 1), while the IB CSE trained undergraduate had a higher Surface Motive and Deep Approach than the E group. The E and IB CSE were the same in highly valuing the importance of data organization strategies and both rated this factor higher than the non-IB undergraduates. Finally, the IB trained Education undergraduate was significantly different than the non-IB Education undergraduate in assigning a higher importance rating to teacher and student co-construction of inquiry learning.

Figure 1

The figure shows the distribution of two groups of IB students with relation to Surface Motives (on the x-axis) and the sophistication of epistemic beliefs (y-axis)



This complex pattern of results suggests that Education IB trained students recognize the importance of a co-operative and collaborative relationship between the student and the teacher when undertaking the inquiry process in the classroom. By emphasizing co-construction of inquiry learning more than the non-IB student, they may be actually acknowledging their dependence on the teacher rather than expecting to take increasing responsibility for themselves. This is an issue that we hope to understand more after Phase

II of the project.

Table 2
Summary of Research Questions

(1) Research Question	*(2) Stats Designs*	*(3) Specific Stats Tests*	*(4) Significant Results or Variance Explained*	*(5) Does the evidence support IB EE?*
Phase I Quantitative Analyses				
2. How do IB DP graduates at McGill compare to non-IB DP graduates in terms of inquiry self-efficacy, inquiry values, epistemic beliefs, approach to learning, and beliefs about the nature of science?	ANOVA, MANOVA	A 2x1 ANOVA was run for the two groups on the total scores for each of the SDEIQ, MSDIQ, SEBQ, LPQ, and VNOS-C instruments. Subsequent MANOVA were also run on the factor scores for each of the measures. SDEIQ: 2X7 MANOVA MSDIQ: 2X14 MANOVA SEBQ: 2X12 MANOVA LPQ: 2X6 MANOVA VNOS-C: 2X7 MANOVA	No significant results were obtained for the SDEIQ. Four significant results were obtained for the MSDIQ factors 2. Generative Inquiry ($F(1, 90) = 4.556$, $p = .036$, $\eta^2 = .048$), 6. Co-Construction of Inquiry ($F(1, 90) = 4.523$, $p = .036$, $\eta^2 = .048$) 8. Student Inquiry Communication Strategies ($F(1, 90) = 4.473$, $p = .037$, $\eta^2 = .047$) and 13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences ($F(1, 90) = 6.898$, $p = .010$, $\eta^2 = .071$). No significant result was obtained for the SEBQ ANOVA. The SEBQ MANOVA was significant ($\Lambda = .744$, $F(12, 109) = 3.131$, $p = .001$, $\eta^2 = .256$). Between-subject effects below showed that factors 4, 5, and 11 present significant differences (4. Knowledge is Certain $F(1, 120) = 3.963$, $p = .049$, $\eta^2 = .032$), 5. Depend on Authority ($F(1, 120) = 4.231$, $p = .042$, $\eta^2 = .034$), 11. Learn Quick ($F(1, 120) = 13.039$, $p = .000$, $\eta^2 = .098$).) The LPQ ANOVA did not reveal a significant difference for total score. The LPQ MANOVA revealed a significant multivariate effect ($\Lambda = .925$, $F(6, 105) = 1.418$, $p = .214$, $\eta^2 = .075$). Between-subject effects were significant for 1. Surface Motivation $F(1, 112) = 4.542$, $p = .035$, $\eta^2 = .040$). No significant results were found for the VNOS-C.	YES MsDIQ (Integration 2 $M = .13$ ($SD = .12$) > $M = .30$ ($SD = .13$) Reflection 1 $M = .16$ ($SD = .12$) > $M = -.08$ ($SD = .41$)) SEBQ (Knowledge is Certain $M = 2.90$ ($SD = .06$) < $M = 3.08$ ($SD = .07$) Depend on Authority $M = 2.93$ ($SD = .08$) < $M = 3.18$ ($SD = .09$) Learning is Quick $M = 2.84$ ($SD = .05$) < $M = 3.11$ ($SD = .06$)) LPQ (Surface Motivation $M = 15.46$ ($SD = .48$) < $M = 16.96$ ($SD = .52$))
3. What proportion	Multiple	1X4 run twice for	The two multiple regressions reported below tested how	YES

of the variability in the importance attributed to inquiry strategies ranked as important by experts, is accounted for by IB schooled and non-IB schooled undergraduates' inquiry self-efficacy, epistemic beliefs, approach to learning, and beliefs about the nature of science?	regression	IB and for non-IB	well four measures of inquiry learning predicted inquiry valuing. In other words, how well do beliefs—about epistemology, inquiry self-efficacy, and science—predict how one values the strategic importance of inquiry tasks. The analysis was run twice: first, for IB graduates, and second, for non-IB graduates. In the first instance, the test of the full model with all four predictors was statistically significant ($F(4,29) = 7.234$, $p = .000$). The model accounted for a medium amount of variance (Adjusted $R^2 = .430$) Learning Processes ($\beta = -.299$, $t = -1.637$, $p = .004$) and Views of Science ($\beta = -.052$, $t = -.390$, $p = .011$) were significant predictors of inquiry valuing. In the second instance, the test of the full model with all four predictors was also statistically significant ($F(4,21) = 4.021$, $p = .014$). The model accounted for a smaller amount of variance (Adjusted $R^2 = .326$). Learning Processes ($\beta = -.315$, $t = -1.361$, $p = .009$) and Views of Science ($\beta = -.152$, $t = -.637$, $p = .037$) were significant predictors of inquiry valuing.	Comparing the two groups, one notices no differential prediction weights for the two groups. For both IB and non-IB graduates, the approach to learning and Views of Science are significant predictors of Inquiry Valuation but they are more important predictors for IB students relative to non-IB students in terms of their predictive power, i.e. the amount of variance accounted for which is 43% for IB versus 33% for the Non-IB
4. What variables best account for membership in IB and non-IB groups that assign a high importance to Inquiry instruction and learning?	Logistic regression	1X4 run twice for IB and for non-IB	The analysis was run twice: first, for IB graduates, and second, for non-IB graduates. In the first instance, the test of the full model with all four predictors against the constant-only model was statistically significant, $\chi^2(4, 14.668, p = .005)$ indicating that the group of predictors reliably identified the high valuing inquiry groups. The variance accounted for is small, Nagelkerke $R^2 = .482$. Classification is poor, 58.3% low inquiry, 86.4% high inquiry, and 76.5% overall. The Wald criterion provides an estimation of the significance of the weighted contribution of each variable to the overall prediction of group membership. Inquiry self-efficacy is a significant	YES Comparing the two groups, one notices that inquiry self-efficacy and epistemological beliefs contribute differently to predicting inquiry valuing. Inquiry self-efficacy is a significant predictor for inquiry valuing for IB graduates but not for non-IB graduates. Epistemological beliefs also contribute in different proportions to predicting inquiry

			estimator of inquiry valuation (W = 3.955, *p* = .047). The exponential function of the coefficients provides an estimate of the log-odds ratios for each of the predictors; it provides an estimate of the constant change in the dependent variable given a proportional change in the independent variable. Inquiry self-efficacy and inquiry valuation are at 2.803:1, Epistemological Beliefs are .416:1, Learning Processes .928:1, and Views of Science 1.000:1. In the second instance, the test of the full model with all four predictors against the constant-only model was statistically significant, $\chi^2(4, 10.062, p = .039)$ indicating that the group of predictors reliably distinguished between the high and low inquiry groups. The variance accounted for is small, Nagelkerke $R^2 = .443$. Classification is relatively good, 88.2% low inquiry, 77.8% high inquiry, and 84.6% overall. The Wald criterion provides an estimation of the significance of the weighted contribution of each variable to the overall prediction of group membership. In this case, none of the variables is a significant estimator of inquiry valuation. The exponential function of the coefficients provides an estimate of the log-odds ratios for each of the predictors; it provides an estimate of the constant change in the dependent variable given a proportional change in the independent variable. Inquiry self-efficacy and inquiry valuation are at 1.769:1, Epistemological Beliefs are 3.042:1, Learning Processes .937:1, and Views of Science 949:1.
Pre-Service Teachers	ANOVA, MANOVA	2X1 ANOVA, 2X12 MANOVA	

5. Is there a significant difference between epistemic beliefs of pre-service teachers graduating from IB DP schooling compared to non-IB pre-service teachers?			No significant result was obtained for the SEBQ ANOVA. The SEBQ MANOVA was ($\Lambda = .857$, $F(12, 58) = 4.142$, $p = .000$, $\eta^2 = .461$). Between-subject effects below showed that factors 1, 3, and 12 present significant differences (1. Seek Single Answers $F(1, 69) = 4.420$, $p = .060$, $\eta^2 = .121$), 3. Avoid Ambiguity ($F(1, 69) = 6.035$, $p = .017$, $\eta^2 = .080$), 12. Concentrated Effort ($F(1, 69) = 14.577$, $p = .000$, $\eta^2 = .174$).)	QUALIFIED YES Seek Single Answers $M = 2.97$ ($SD = .06$) > $M = 2.71$ ($SD = .11$) Avoid Ambiguity $M = 3.07$ ($SD = .08$) > $M = 2.68$ ($SD = .14$) Concentrated Effort $M = 3.00$ ($SD = .09$) > $M = 2.25$ ($SD = .17$)
6. Is there a significant difference between the learning approaches of pre-service teachers graduating from IB DP schooling compared to non-IB pre-service teachers?	ANOVA, MANOVA	2X1 ANOVA, 2X6 MANOVA	The LPQ ANOVA did not reveal a significant difference for total score. The LPQ MANOVA revealed a significant multivariate effect ($\Lambda = .847$, $F(6, 54) = 1.620$, $p = .159$, $\eta^2 = .153$). Between-subject effects were significant for 1. Surface Motivation $F(1, 59) = 4.146$, $p = .046$, $\eta^2 = .066$) and 4. Deep Approach $F(1, 59) = 6.437$, $p = .014$, $\eta^2 = .098$).	QUALIFIED YES Surface Motivation $M = 15.46$ ($SD = .55$) < $M = 17.73$ ($SD = .97$) Deep Approach $M = 20.78$ ($SD = .58$) < $M = 23.73$ ($SD = .1.01$)
7. Is there a significant difference between the MSDIQ Scores of IB and non-IB undergraduate pre-service teachers?	ANOVA, MANOVA	2X1 ANOVA, 2X12 MANOVA	An ANOVA was run for the two groups on the total score for the MSDIQ. A Subsequent MANOVA was run on the factor scores for the instrument. One significant result was obtained for the MSDIQ factor Preparation 6 ($F(1, 91) = 4.293$, $p = .013$, $\eta^2 = .066$) and Reflection 1 ($F(1, 91) = 6.045$, $p = .006$, $\eta^2 = .080$).	YES Preparation 6 $M = .30$ ($SD = .12$) > $M = –.37$ ($SD = .23$) Reflection 1 $M = .12$ ($SD = .15$) > $M = –.32$ ($SD = .28$)
8. Is there a	ANOVA,	2X1 ANOVA,	An ANOVA was run for the two groups on the total score	

significant difference between the inquiry self-efficacy of pre-service teachers graduating from IB DP schooling compared to each other and to non-IB pre-service teachers?	MANOVA	2X7 MANOVA	for the SDEIQ. A Subsequent MANOVA was run on the factor scores for the instrument. No significant results were obtained for the SDEIQ.

Following Phase I, interviews will be conducted aimed at understanding the remaining research questions:

1. How does the IB extended essay compare to the CEGEP extended essay in design?

10. How well are the aims of the extended essay achieved and sustained as students continue through post-secondary education?

11. How do DP students:
    a. define meaningful learning at the university
    b. perceive they participate in studying and courses in their major area
    c. describe their confidence in the ability to accomplish the academic demands of course
    d. describe their motivation to participate in as well as actually do inquiry at the university outside of courses such as by applying for work as a researcher in a funded research project
    e. describe the impact of the IB EE on university learning?

12. Do the conceptions of inquiry and the descriptions of inquiry instruction differ qualitatively among the following groups:
    a. IB schooled undergraduates
    b. non-IB schooled undergraduates who have completed the CEGEP EE
    c. non-IB schooled undergraduates who have not completed the IB EE or the CEGEP EE?

RATIONALE AND METHODOLOGY

Context

This study uses students identified by the Records office of a university that emphasizes research and is ranked among the top 20 in the world. Thus, all undergraduate students must meet highly competitive academic standards to be accepted at the university. The students entering the university were prepared in a variety of secondary schools. Some, but not a majority, attended an IB Diploma Program before entering the university.

The students included in this study were former IB students and non-IB students sampled from the Faculty of Education and the Faculty of Sciences. The IB students majoring in different disciplines affords a sample of convenience that allows for differences in the goals for an undergraduate academic degree within the IB group (Science and Education) and the non-IB group (Science and Education).

Table 3
Student enrollment by diploma and degree group

		Degree Group			*Total*
		Edu.	Sci.	Arts	
Diploma Group	IB	145	18	2	165
	Non-IB	47	46	4	97
	Other	31	7	2	40
Total		223	71	8	302

This study included measures of epistemic beliefs, conceptual knowledge of the nature of science, the depth of the learners approach to learning, students' self-efficacy as an inquirer, and student ratings of the importance of different instructional and learning demands of engagement in inquiry. These measures were selected to be reliable and valid but also to reflect what current research in higher education demonstrates to be powerful variables that have already been shown to affect and be affected by inquiry instruction and learning. The extended essay is in effect a form of inquiry, as discussed in the current literature and IB documents (IBO, 2007), and it requires formal inquiry instruction as well as time and opportunity for students to learn how to lead an inquiry with gradually increasing independence.

Views on the Nature of Science. The nature of science (as measured by the VNOS-C) refers to the epistemology and sociology of science, which represents the values and tacit beliefs inherent and embedded in the development of scientific knowledge (Abd-El-Khalick, Bell, & Lederman, 1998; Hammerich, 2002; Lederman, 1992). Studies about the nature of science seek answers to questions of what science is,

how it pursues its inquiry, what the nature of scientific knowledge is, what values are embedded in scientific knowledge and perceptions about science as a way of knowing (Abd-El-Khalick, et al., 1998; Atar, 2007).

An understanding of science involves gaining insights mainly in two facets: knowledge in science and knowledge about the nature of science (Ryder, Leach, & Driver, 1999). Knowledge in science denotes knowledge of the domains of science such as laws, models, theories, concepts, ideas, and experimental techniques of science (Lederman, 1992; Loving, 1991; Ryder, et al., 1999). On the other hand, some knowledge experts suggest that it is necessary to distinguish scientific processes from the nature of science. While scientific processes denote the activities related to the collection, interpretation and derivation of conclusions from data, the views on the nature of science survey (VNOS-C) represents the epistemological assumptions underlying such scientific activities (Abd-El-Khalick, et al., 1998; Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002). In short, undergraduate students' views about the nature of science represent the ways by which aspects of scientific knowledge, scientific processes and practices are perceived. In this regard, the VNOS-C complements the Schommer measure.

Epistemic Beliefs. Epistemology is the branch of philosophy concerned with the nature of knowledge, its possibility, scope, general basis, and the justification of belief (Honderich, 1995). The study of epistemic beliefs has become a recent and valuable line of inquiry for educational researchers. Evidence suggests that epistemic beliefs are related to cognition, motivation, mathematical learning (Muis, 2004; Muis & Foy, 2010; Muis & Franco, 2009), and self-regulation (Muis, 2004; Muis & Franco, 2009). Epistemic beliefs affect how students approach problem solving in mathematics (Schoenfeld, 1989), monitor their comprehension of what is read, and directly and indirectly affect achievement (Schommer, 1990; Schommer, 1993). Epistemic beliefs have been demonstrated to have a significant relationship to a variety of strategies necessary to engage in inquiry when broadly defined. This study uses the Schommer-Aikins Epistemic Beliefs Questionnaire (SEBQ) (Schommer, 1990; Schommer-Aikins, Duell, & Barker, 2003), which is one widely used general measure of epistemic beliefs. The SEBQ has been shown empirically to be significantly related to the reading comprehension and performance on achievement tests of college students (Schommer, 1990).

Learning Process. A student's approach to learning (Marton & Säljö, 1976) has been found to be significantly related to the quality of learning outcomes in academic courses in both high school and university. Research has demonstrated that undergraduate students have different motives and strategies for learning in university courses (Biggs, Kember, & Leung, 2001; Biggs, 1987b). Moreover, research originated by Biggs has obtained empirical evidence that students' learning approaches may typically fall into surface motives and strategies and deep motives and strategies (Biggs, et al., 2001). Since inquiry is largely motivated by the desire for deep rather than surface knowledge of a phenomenon, students holding a deep motive and deep approach to learning may place different weight on the importance

of different elements of the inquiry process that underlie the accomplishment of the extended essay. In short, the Learning Process Questionnaire (Biggs, 1987a) was selected to determine if participation in the EE and the IB DP curriculum influences undergraduate students' approach to learning and whether self-efficacy contributes to the value that IB students place on inquiry instruction and learning compared to non-IB students.

Self-efficacy. Self-efficacy (Bandura, 1997) is the extent to which learners feel they can succeed in a situation (including specific tasks), such as doing research, or solving mathematics problems in a classroom. It has been shown to be a powerful predictor of college-student achievement (Chemers, Hu, & Garcia, 2001), choice of academic major and of career (Solberg et al., 1994). This study measures self-efficacy as related to inquiry, using the McGill Inquiry Self-efficacy Questionnaire (SDEIQ). The SDEIQ was created based on the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ) (Shore, et al., 2012) and uses the same items but asks students to rate how confident they are about accomplishing the inquiry strategies. Bandura (1986) states that "self-efficacy is the belief in one's capabilities to organize and execute the sources of action required to manage perspective situations." Self-efficacy also influences the choice of inquiry activities one engages in (or not) and the persistence to learn how to inquire and give effort to becoming an inquirer. Moreover, people exert control through the processes of self-efficacy and self-regulation (Bandura, in Schunk and Zimmerman (2007)). Pre-service teachers who perceive themselves as inquirers are more likely to make choices as a novice teacher that are different from pre-service teachers who do not see themselves as inquirers.

Pre-service teachers have the option whether or not to teach using an inquiry approach. Those who have low self-efficacy for the accomplishment of inquiry activities may not choose to attempt to teach through an inquiry approach and may have a closed view regarding the benefits to students from inquiry instruction. For example, research results indicate that science students holding a quantitative conception of learning (i.e., conceptualizing it as a quantitative increase in knowledge) tend to adopt a surface-learning approach and perceive their role in the teaching-learning process as a passive one (Prosser & Trigwell, 1999). Consequently, their achievement level in inquiry-based methods classes is likely to be lower compared to that of students who hold a qualitative learning conception (i.e., conceptualizing it as a process aimed at understanding reality and developing as a person), whose approach to learning is deep, and who perceive their role in the teaching-learning process as active. Students holding a surface-learning approach tend to prefer learning environments that are likely to promote rote learning, whereas those who hold a deep approach tend to prefer environments that are likely to promote understanding (Entwistle & Tait, 1990). Again, because conceptual understanding is the goal of inquiry based instruction, those taking a surface approach to learning may find an inquiry based approach to instruction incompatible with their beliefs and actions.

Statistical Analyses

Statistical analyses were run using SPSS 20.0 for the combined population of IB and non-IB students and for the separate Education and Science IB undergraduates. Power analyses were also run using the same software for each statistical analysis and can be found in the Appendices. Given the limited n-sizes of our convenience sample, many analyses reported here suffer from low power. Hence, we can assume that some statistical differences likely remain unidentified by our analytical methods. The undergraduate student's exposure to inquiry as a way of learning may not only be different due to the kind of curriculum design students follow in IB and non-IB schools but also to their secondary school academic major and the long standing hobbies or interests of each individual. By including students from two different academic majors and degrees, some control is provided for threats to internal validity associated with the academic history of the students in the study.

When multiple ANOVAs/t-tests are run it is customary to include a Type I error correction. This makes the alpha level smaller, which makes it more difficult to identify significance, for instance, $p < .0005$ is harder to obtain than $p < .05$. However, given the quasi-experimental and exploratory nature of the studies reported here, the multiple MANOVA/ANOVA do not affect each other. These are not experiments but independent studies that ask *different* questions about *different* groups. This study in effect is looking at different populations, i.e. by discipline, and by diploma. These different studies reported together are not components that report on the same population.

Limitations

Causal inference requires a minimum of three conditions be met: 1) the time order of the variables must be respected. No backward causation; 2) there must be a relationship between the variables. The relationship may or may not be linear but when one variable changes there must be a corresponding change in the other variable; and 3) the relationship must be direct, i.e. not influenced by a third, intervening variable.

This is a quasi-experimental post-test only research design. Quasi-experimental research cannot meet the above three conditions. Quasi-experimental research is correlational because it is limited in its ability to establish causational relationships. The problem with non-experimental and quasi-experimental research is often with the third stipulation on inference. Without controlling extraneous variables as in experimental research it is hard to be certain that there is not another variable responsible for the identified relationship (Johnson & Christensen, 2010).

Threats to the external validity of quasi-experimental research may be influenced by methods of testing for group differences as well as instrumentation. A post-test only design does not have the added benefit of a pre-test, which could be used as a

baseline for comparisons. Issues of instrumentation are also a source of concern. These arise with insufficient evidence of the reliability of the measures used in the study and reliance on univariate measures of a variable when multiple related measures of a variable offer a more realistic and powerful estimate of the magnitude of the influence of the independent treatment variables. This study uses multiple measures of each complex variable to which the treatment might be sensitive and also uses multiple variables to gauge the scope of the influence of the instructional interventions offered by IB and non-IB schools (Onwuegbuzie & Daniel, 2003).

Finally, evidence for the validity and reliability of the MSDIQ instrument (Shore, et al., 2012) is based on student data from the same university as the students in the current study. Rather than use the factors from this previous study, a new factor analysis was performed because the validation study did not include a large sample of Science majors. Recently, Gregorich (2006) argued that rating instruments may not have stable factors when different populations are used.

Measures

McGill Strategic Demands of Inquiry Questionnaire: MSDIQ (Shore, et al., 2012; Syer, 2007): A 79-item questionnaire with an 11-point Likert scale and 3 subscales: Preparation for an Inquiry Project, 29 items (.93), Enactment of the Inquiry Project, 43 items (.96), Reflection on the Enactment, 5 items (.90). Whole-test score reliability is .97. Factor validity was confirmed for each subscale with exploratory and confirmatory factor analyses; construct validity supported the total score. Fourteen factors were identified and organized under the three subscales by Shore et al (2012).

Because the meaning of the scores on survey instruments are especially sensitive to the nature of the population on which they are normed, a different exploratory factor analysis was carried out using the undergraduate students who could be identified from a sample of 300 who had obtained an International Baccalaureate Diploma before enrolling as undergraduates and a second sample of students who received some other secondary preparation but were accepted into the faculty of Sciences or the faculty of Education. The results of this analysis largely confirmed 13 of the 14 factors identified in the previous studies. However, the results suggest different factor groupings for maximal interpretation in this study. The appendices provide the statistical results of the Exploratory Factor Analysis and a description of the factors. Additionally, the organization of the groupings into three dimensions is included. Briefly, exploratory factor analysis results demonstrated that the MSDIQ has 13 factors, which can be organized into three dimensions: 1) basic entry level inquiry strategies, 2) the enactment of social and cognitive strategies that must be primarily self-regulated by the student, and 3) inquiry reflective strategies that enable students to improve their ability to deliberately self-regulate the process of inquiry alone.

Self-efficacy for the Demands of Inquiry Questionnaire (SDEIQ): (Aulls & Shore, 2010). This 69-item instrument is designed to estimate students' confidence in accomplishing inquiry tasks and situations arising when inquiry is engaged in any setting and in formal education settings. It is divided into seven subscales: Interpretation and Presentation of Results (15 items), Domain General Strategies, (12 items), Data Analysis (11 items), Self-regulatory Strategies (10 items), Classroom Cooperation Behaviors During Inquiry Instruction (7 items), Inquiry Disposition (3 items), and Inquiry Small Group Collaboration Behaviors (10 items). An exploratory factor analysis confirms the independence of each subscale and the factorial validity of the measure. Chronbach alpha is .901 for the total score and .938, .915, .903, .880, .837, .663 and .909 for each of the scales in the order given above.

Schommer-Aikins Epistemic Beliefs Questionnaire (**SEBQ):** (Schommer, 1990; Schommer-Aikins, et al., 2003). This 63-item questionnaire has a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Lower scores represent sophisticated beliefs and higher scores naïve beliefs about knowledge. There are 5 knowledge dimensions: certain knowledge, simple knowledge, quick learning, innate ability, and omniscient authority. Confirmatory factor analyses by multiple investigators support 4 of the original 5 factors. Reliability ranges between .70 and .89.

The Biggs Learning Process Questionnaire (LPQ): (Biggs, 1987a, 1987c). This is a 36-item questionnaire designed to measure approaches to learning. The LPQ has six scales, which measure Surface Motive, Surface Strategies, Deep Motive, Deep Strategies, Achieving Motive and Achieving Strategies, each with seven items. However, the motive and strategies within the surface, deep and achieving dimensions of study behavior can be combined to form approaches to study, each with 12 items. The LPQ has been extensively used in studies investigating learning behaviors in tertiary education (Biggs, 1987a, 1987b, 1987c; Biggs, 1988; Biggs, 1996; Biggs, 1999; Biggs, et al., 2001; ; Watkins & Murphy, 1994).

Views of Nature of Science Questionnaire (VNOS-C): (Lederman, et al., 2002) consists of 10 open-ended questions designed to probe views of specific aspects of the scientific enterprise. It is validated for use with the intended participants.

The open-ended nature of the VNOS-C allows respondents to use their own words and examples, without being forced into a choice. Total Score $\alpha = .73$.

Instrument reliability and validity

Cronbach's Alpha is a measure of reliability calculated by comparing item inter-correlations. Scores of .75 and above are considered very good. As the table below shows, alphas for all five instruments were well above that threshold. Additional details on instrument reliability can be found in the Appendices.

Table 4
Instrument reliability

Instrument	*Cronbach's α*	*N of Items*
MSDIQ	.965	67
SDEIQ	.969	69
SEBQ	.837	63
LPQ	.804	36
VNOS-C	.706	85

Summary

This study has been designed to focus on how undergraduate students perceive the importance of various demands of inquiry instruction and learning from the teacher, teacher and student and especially the student's participation in the process. Students were not directly asked or hinted to that it is the extended essay experience being explored. But, it is assumed that their responses are based on their most immediate formal schooling in the last two years prior to entering university (for IB students this corresponds to the two years of the DP). The Phase II interviews and analysis of conceptions of inquiry and descriptions of what students view as effective instruction will bring a closer lens to how the two actually are experienced by each participant in this Phase I study. Phase I compares IB DP schooled undergraduates to those who do not have an IB Diploma on this variable and on the variables of epistemic beliefs, knowledge of science, preference for deep and/or surface approaches to learning and self-efficacy as an inquirer. The end result should offer multiple sources of evidence of how IB and non-IB students are alike and different. Those who are majoring in Education are separated from those students majoring in the Sciences so that the nature of the IB influence on different professional groups can be examined. Next, it is attempted to determine how much of the variance in IB and non-IB undergraduate students ratings of the importance of inquiry instruction and learning can be accounted for by their epistemic beliefs, knowledge of science, approach to learning, and self-efficacy.

When possible, current and relevant higher education research findings are related to the results for each major research question and a final discussion of implications is included, which raise questions for future consideration by the IB and those it serves.

INTRODUCTION: Research Question 2

Research question

How do IB DP graduates at McGill compare to non-IB DP graduates in terms of inquiry self-efficacy, inquiry values, epistemic beliefs, approach to learning, and beliefs about the nature of science?

Significant results

Self-efficacy for the Demands of Inquiry Questionnaire (SDEIQ)

Instrument: This 69-item instrument (Aulls & Shore, 2010) is designed to estimate students' confidence in accomplishing inquiry tasks and situations arising when inquiry is engaged in any setting and in formal education settings.

Statistical analyses: 2X1 ANOVA, 2X7 MANOVA

Significant results: No significant results were obtained for the SDEIQ.

McGill Strategic Demands of Inquiry Questionnaire (MSDIQ)

Instrument: A 79-item questionnaire (Shore, et al., 2012; Syer, 2007) with an 11-point Likert scale and 3 subscales: Preparation for an Inquiry Project, 29 items (.93), Enactment of the Inquiry Project, 43 items (.96), Reflection on the Enactment, 5 items (.90). The MSDIQ asks participants to assign value to aspects of inquiry. Briefly, exploratory factor analysis results demonstrated that the MSDIQ has 13 factors which can be organized into three dimensions: 1) basic entry level inquiry strategies, 2) the enactment of social and cognitive strategies that must be primarily self-regulated by the student, and 3) inquiry reflective strategies that enable students to improve their ability to deliberately self-regulate the process of inquiry alone.

Statistical analyses: 2X1 ANOVA, 2X13 MANOVA

Significant results: Four significant results were obtained for the MSDIQ factors. Factor 2. Generative Inquiry ($F(1, 90) = 4.556$, $p = .036$, $\eta^2 = .048$), Factor 6. Co-Construction of Inquiry ($F(1, 90) = 4.523$, $p = .036$, $\eta^2 = .048$) Factor 8. Student Inquiry Communication Strategies ($F(1, 90) = 4.473$, $p = .037$, $\eta^2 = .047$) and Factor 13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences ($F(1, 90) = 6.898$, $p = .010$, $\eta^2 = .071$).

Table 5
MSDIQ mean differences

Factor	*IB Graduates*		*Non-IB Graduates*
2. Generative Inquiry	*M* = 8.36 (*SD* = .24)	>	*M* = 7.61 (*SD* = .26)
6. Co-Construction of Inquiry	*M* = 7.38 (*SD* = .32)	>	*M* = 6.40 (*SD* = .34)
8. Student Inquiry Communication Strategies	*M* = 7.68 (*SD* = . 24)	>	*M* = 6.93 (*SD* = . 26)
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	*M* = 8.09 (*SD* = .24)	>	*M* = 7.17 (*SD* = . 26)

Schommer's Epistemological Beliefs Questionnaire (SEBQ)

Instrument: This 63-item questionnaire (Schommer, 1990; Schommer-Aikins, et al., 2003) has a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Lower scores represent sophisticated beliefs and higher scores naïve beliefs about knowledge.

Statistical analyses: 2X1 ANOVA, 2X12 MANOVA

Significant results: No significant result was obtained for the SEBQ ANOVA. The SEBQ MANOVA was significant ($\Lambda = .744$, $F(12, 109) = 3.131$, $p = .001$, $\eta^2 = .256$). Between-subject effects below showed that factors 4, 5, and 11 present significant differences (4. Knowledge is Certain $F(1, 120) = 3.963$, $p = .049$, $\eta^2 = .032$), 5. Depend on Authority ($F(1, 120) = 4.231$, $p = .042$, $\eta^2 = .034$), 11. Learn Quick ($F(1, 120) = 13.039$, $p < .000$, $\eta^2 = .098$).)

Table 6
SEBQ mean differences

Factor	*IB Graduates*		*Non-IB Graduates*
Knowledge is Certain	*M* = 2.90 (*SD* = .06)	<	*M* = 3.08 (*SD* = .07)
Depend on Authority	*M* = 2.93 (*SD* = .08)	<	*M* = 3.18 (*SD* = .09)
Learning is Quick	*M* = 2.84 (*SD* = .05)	<	*M* = 3.11 (*SD* = .057)

Learning Processes Questionnaire (LPQ)

Instrument: This is a 36-item questionnaire (Biggs, 1987a, 1987c) designed to measure approaches to learning. The LPQ and its companion, the SPQ, were developed in the 1970s to measure approaches to learning. The LPQ is designed for use at the school-level and was therefore used in this study. This instrument examines motives and strategies for three approaches to learning: surface, deep, and achieving. Surface learning relies on memorization, while deep learning relies on developing understanding.

Statistical analyses: 2X1 ANOVA, 2X6 MANOVA

Significant results: The LPQ ANOVA did not reveal a significant difference for total score. The LPQ MANOVA revealed a significant multivariate effect ($\Lambda = .925$, $F(6, 105) = 1.418$, $p = .214$, $\eta^2 = .075$). Between-subject effects were significant for 1. Surface Motivation $F(1, 112) = 4.542$, $p = .035$, $\eta^2 = .040$).

Table 7
LPQ MANOVA mean differences

Factor	*IB Graduates*		*Non-IB Graduates*
Surface Motivation	*M* = 15.46 (*SD* = .48)	<	*M* = 16.96 (*SD* = .52)

Views of the Nature of Science Education (VNOS-C)

Instrument: VNOS-C (Lederman, et al., 2002) consists of 10 open-ended questions designed to probe views of specific aspects of the scientific enterprise and scientific thinking. It is designed to measure understanding of the tenets of the nature of science.

Statistical analyses: 2X1 ANOVA, 2X7 MANOVA

Significant results: No significant results were found for the VNOS-C.

RESULTS

This section explores results for the three instruments with significant results, the MSDIQ, the SEBQ, and the LPQ.

MSDIQ MANOVA

Descriptive statistics

For the MSDIQ MANOVA, group 1 included 49 IB graduates and group 2 included 43 non-IB graduates.

The means and standard deviations for the IB and non-IB students as well as the totals for each factor are listed in the table below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Table 8
MSDIQ descriptive statistics

	Diploma Group	*Mean*	*Std. Deviation*	*N*
1. Inquiry Comprehension	1	8.65	1.51	49
	2	8.22	1.60	43
	Total	8.45	1.56	92
2. Generative Inquiry	1	8.36	1.85	49
	2	7.61	1.46	43
	Total	8.01	1.71	92
3. Inquiry Planning	1	7.48	1.70	49
	2	7.10	2.32	43
	Total	7.31	2.01	92
4. Problem Solving	1	6.92	1.94	49
	2	6.59	1.58	43
	Total	6.77	1.78	92
5. Inquiry Teaching	1	7.76	1.74	49
	2	7.06	1.86	43
	Total	7.43	1.82	92
6. Co-Construction of Inquiry	1	7.38	1.97	49
	2	6.40	2.46	43
	Total	6.92	2.25	92
7. Student Data Organization Strategies	1	7.56	1.90	49
	2	7.21	2.44	43
	Total	7.40	2.16	92
8. Student Inquiry Communication Strategies	1	7.68	1.51	49
	2	6.93	1.87	43
	Total	7.33	1.72	92

9. Student Formal Reasoning Inquiry Strategies	1	8.29	1.52	49
	2	7.78	1.94	43
	Total	8.05	1.74	92
10. Student Data Interpretation Strategies	1	7.91	1.80	49
	2	7.83	1.41	43
	Total	7.87	1.62	92
11. Student Self-Regulation Strategies for Inquiry Engagement	1	7.78	1.93	49
	2	7.35	1.61	43
	Total	7.58	1.79	92
12. Student Search Strategies	1	7.88	1.92	49
	2	7.69	1.92	43
	Total	7.79	1.91	92
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	1	8.09	1.90	49
	2	7.17	1.35	43
	Total	7.66	1.72	92

Test of assumptions

While ANOVA/MANOVA are largely robust to violations of its core assumptions, of normality and homoscedasticity, it is recommended to test against large departures from these assumptions. While some of the tests reported violations of the assumptions of homogeneity of variances-covariances, data distribution and cell counts make us confident that these violations are only minor and do not affect the interpretability of the results. Please see the appendices for the test results.

Multivariate test

The multivariate test did not reveal a significant difference between groups. Please see the appendices for the test results.

Between-subject tests

The table of between-subject effects below shows that factors 2. Generative Inquiry, 6. Co-Construction of Inquiry ($F(1, 90) = 4.523$, $p < .036$, partial $\eta^2 = .048$), 8. Student Inquiry Communication Strategies ($F(1, 90) = 4.473$, $p = .037$, partial $\eta^2 = .047$), and 13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences ($F(1, 90) = 6.898$, $p = .010$, partial $\eta^2 = .071$) present a significant difference between the two groups however all the effects are relatively small. Further, powers are weak across all the factors. The only exceptions being the three significant factors named above, which have the largest partial η^2 and the strongest power (6. 55.7%, 8. 55.3%, and 13. 73.8%).

Group distributions

Figure 2
MSDIQ Factor #2 Generative Inquiry group distributions

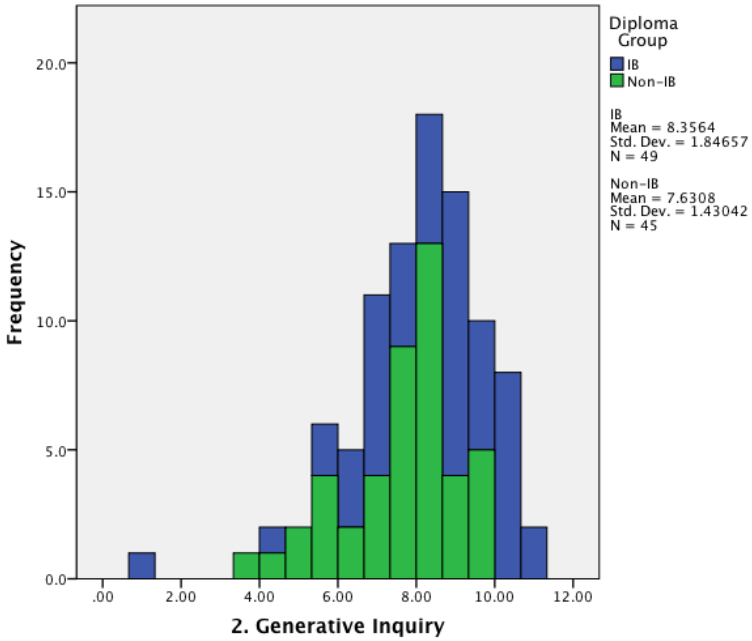


Figure 3
MSDIQ Factor #6 Co-Construction of Inquiry group distributions

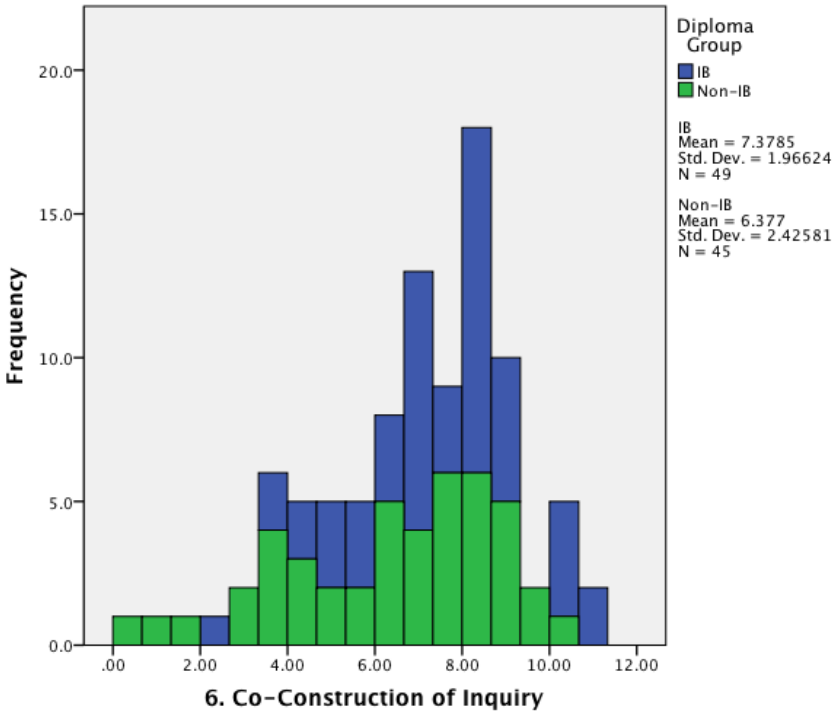


Figure 4
MSDIQ Factor #8 Student Inquiry Communication Strategies group distributions

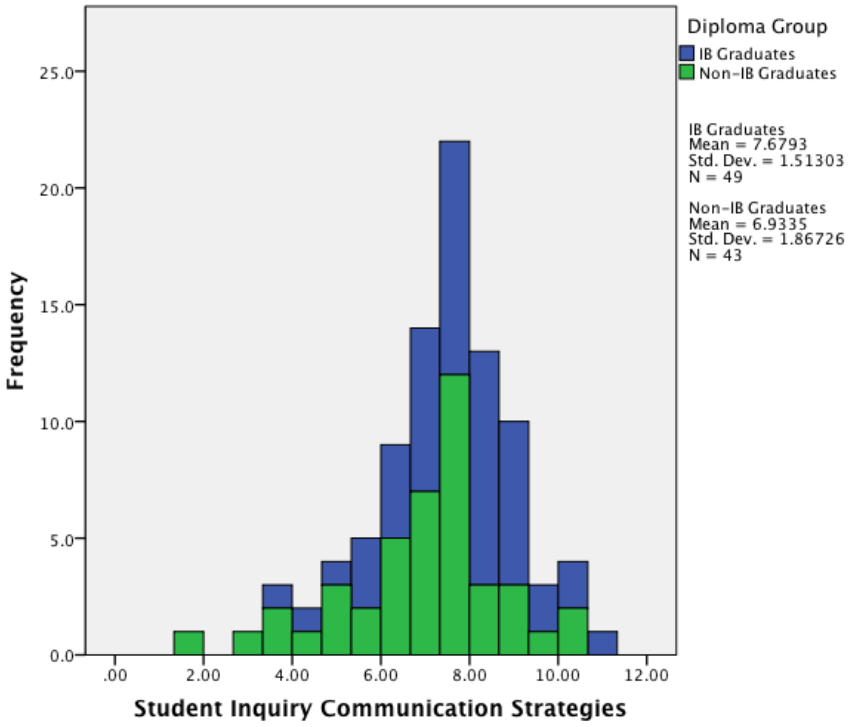
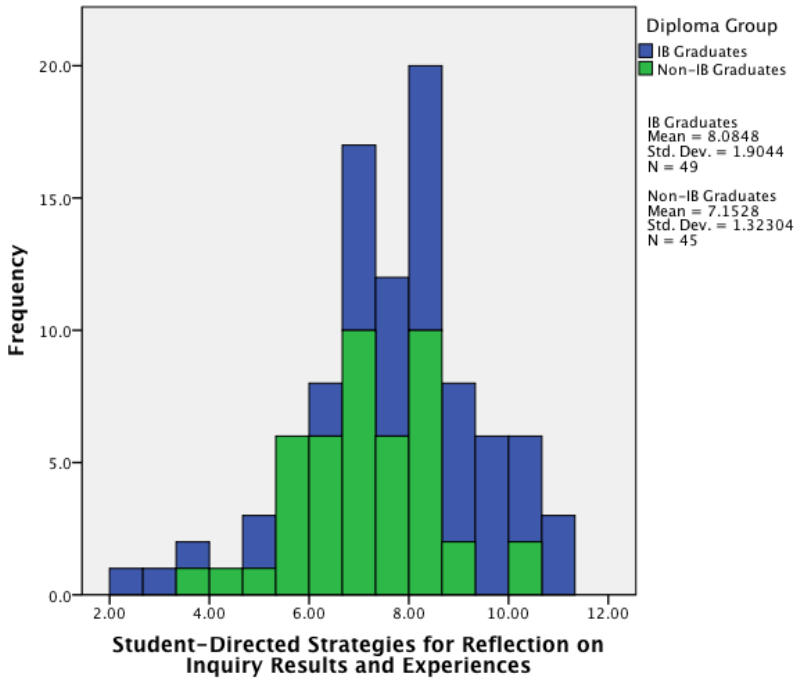


Figure 5
MSDIQ Factor #4 Student-Directed Strategies for Reflection on Inquiry Results and Experiences group distributions



SEBQ MANOVA

Descriptive statistics

For the SEBQ MANOVA, group 1 included 68 IB graduates and group 2 included 54 non-IB graduates.

The means and standard deviations for the IB and non-IB students as well as the totals for each factor are listed in the table below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Table 9

SEBQ descriptive statistics

	Diploma Group	Mean	Std. Deviation	N
Seeks Single Answers	IB Graduates	2.98	.44	68
	Non-IB Graduates	2.92	.47	54
	Total	2.96	.45	122
Avoid Integration	IB Graduates	3.05	.42	68
	Non-IB Graduates	3.04	.51	54
	Total	3.05	.46	122
Avoid Ambiguity	IB Graduates	3.06	.57	68
	Non-IB Graduates	2.89	.65	54
	Total	2.98	.61	122
Knowledge is Certain	IB Graduates	2.90	.44	68
	Non-IB Graduates	3.08	.57	54
	Total	2.98	.50	122
Depend on Authority	IB Graduates	2.93	.72	68
	Non-IB Graduates	3.18	.60	54
	Total	3.04	.68	122
Don't Criticize Authority	IB Graduates	2.68	.43	68
	Non-IB Graduates	2.80	.46	54
	Total	2.73	.44	122
Ability to Learn	IB Graduates	2.55	.62	68
	Non-IB Graduates	2.60	.67	54

	Total	2.57	.64	122
	IB Graduates	3.72	.51	68
Can't Learn How to Learn	Non-IB Graduates	3.65	.56	54
	Total	3.69	.54	122
	IB Graduates	3.60	.52	68
Success Not Hard Work	Non-IB Graduates	3.49	.57	54
	Total	3.55	.55	122
	IB Graduates	2.75	.48	68
Learn First Time	Non-IB Graduates	2.71	.58	54
	Total	2.73	.52	122
	IB Graduates	2.84	.35	68
Learning is Quick	Non-IB Graduates	3.11	.49	54
	Total	2.96	.44	122
	IB Graduates	3.05	.74	68
Concentrated Effort	Non-IB Graduates	2.81	.80	54
	Total	2.95	.77	122

Test of assumptions

Tests were largely non-significant suggesting that the assumption of the homogeneity of variances-covariances and equality of variances are tenable.

Multivariate test

The multivariate test revealed a significant difference between groups ($\Lambda = .744$, $F(12, 109) = 3.131$, $p < .001$, partial $\eta^2 = .256$). The MANOVA had strong power .990.

The table of between-subject effects below shows that factors 4. Knowledge is certain ($F(1, 120) = 3.963$, $p = .049$, partial $\eta^2 = .032$), 5. Depend on Authority ($F(1, 120) = 4.231$, $p = .042$, partial $\eta^2 = .034$), and 11. Learn Quick ($F(1, 120) = 13.032$, $p = .000$, partial $\eta^2 = .098$), present significant differences between the two groups however all the effects are relatively small as can be noted in the Partial Eta Squared column of the following table. As can be seen in the same table, observed power for each factor was relatively weak. Factor 4, 5, and 11 represent the variables with the strongest power (50.6%, 53.2%, 94.8% respectively).

Group Distributions

Figure 6
SEBQ Factor #4 Knowledge is certain group distributions

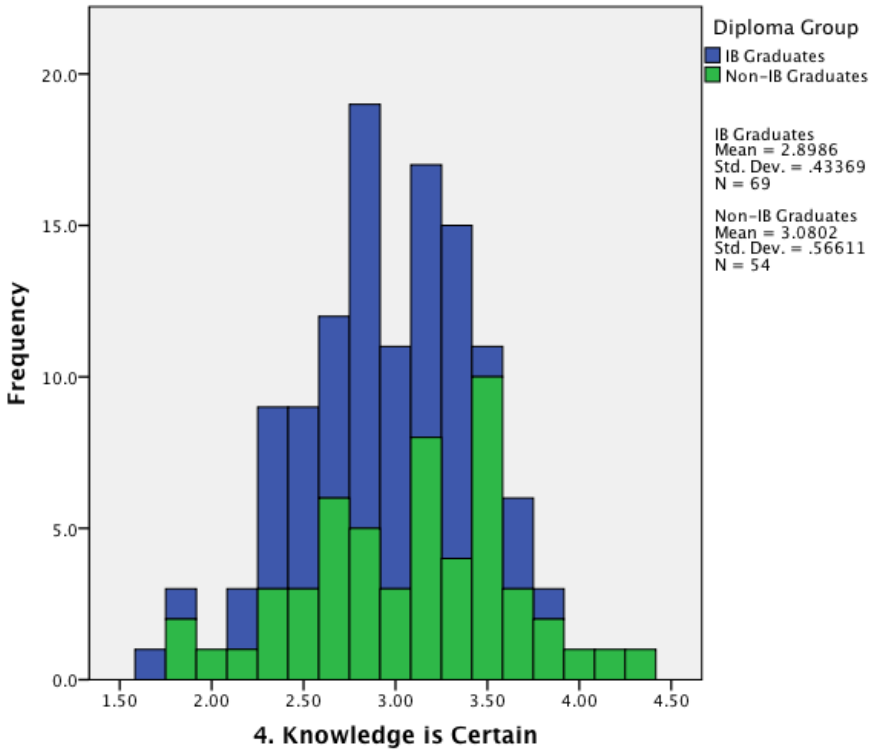


Figure 7
SEBQ Factor #5 Depend on Authority group distributions

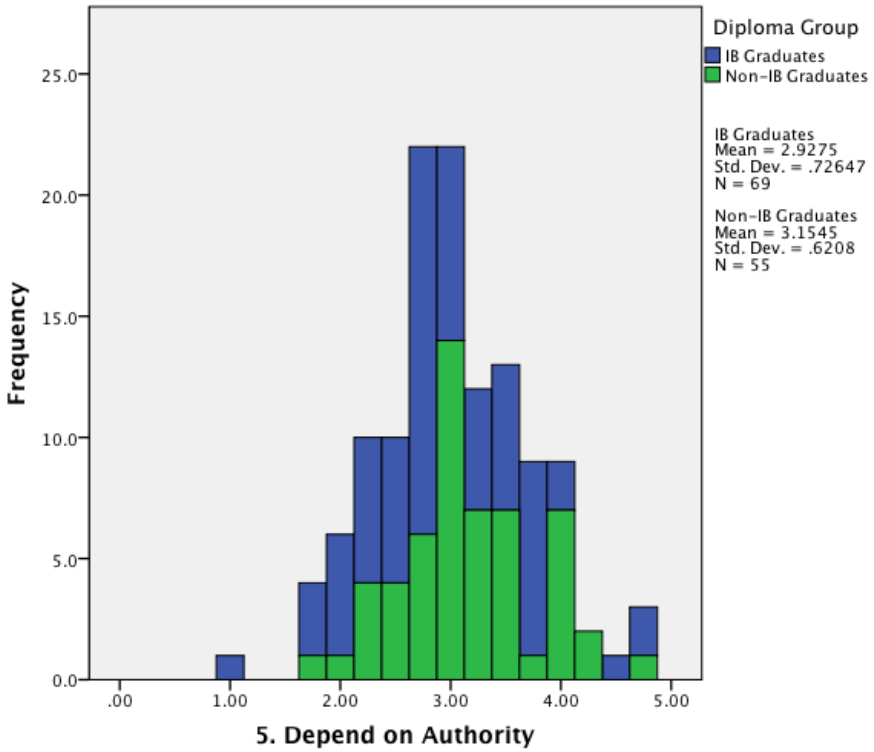
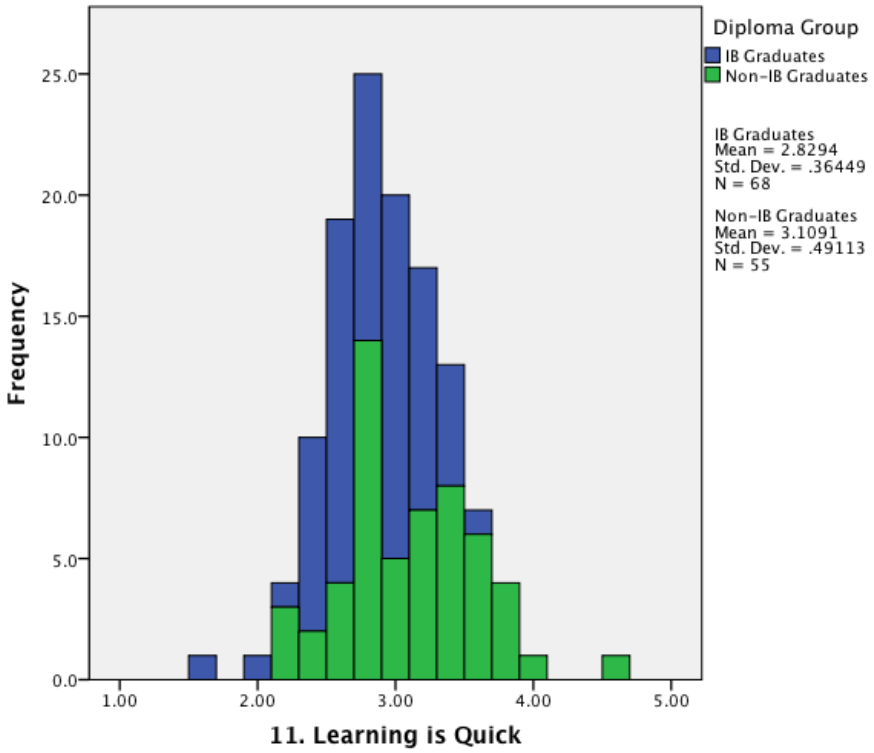


Figure 8
SEBQ Factor #11 Learning is Quick group distributions



LPQ MANOVA

Descriptive statistics

For the LPQ MANOVA, group 1 included 61 IB graduates and group 2 included 51 non-IB graduates.

The means and standard deviations for the IB and non-IB diploma as well as the totals for each factor are listed in the table below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Table 10
LPQ descriptive statistics

	Diploma Group	*Mean*	*Std. Deviation*	*N*
Surface Motive	IB Graduates	15.46	3.60	61
	Non-IB Graduates	16.96	3.85	51
	Total	16.14	3.77	112
Surface Approach	IB Graduates	15.93	4.02	61
	Non-IB Graduates	15.96	4.35	51
	Total	15.95	4.15	112
Deep Motive	IB Graduates	15.51	4.62	61
	Non-IB Graduates	15.41	4.35	51
	Total	15.46	4.48	112
Deep Approach	IB Graduates	20.82	4.04	61
	Non-IB Graduates	22.27	4.23	51
	Total	21.48	4.17	112
Achievement Motive	IB Graduates	16.92	3.90	61
	Non-IB Graduates	15.75	4.56	51
	Total	16.38	4.24	112
Achievement Approach	IB Graduates	19.21	4.80	61
	Non-IB Graduates	18.84	4.87	51
	Total	19.04	4.81	112

Test of assumptions

While ANOVA/MANOVA are largely robust to violations of its core assumptions, normality and homoscedasticity, it is recommended to test against large departures from these assumptions. While some of the tests reported violations of the assumptions of homogeneity of variance-covariance, data distribution and cell counts make us confident that these violations are only minor and do not affect the interpretability of the results. Please see the appendices for the test results.

Multivariate test

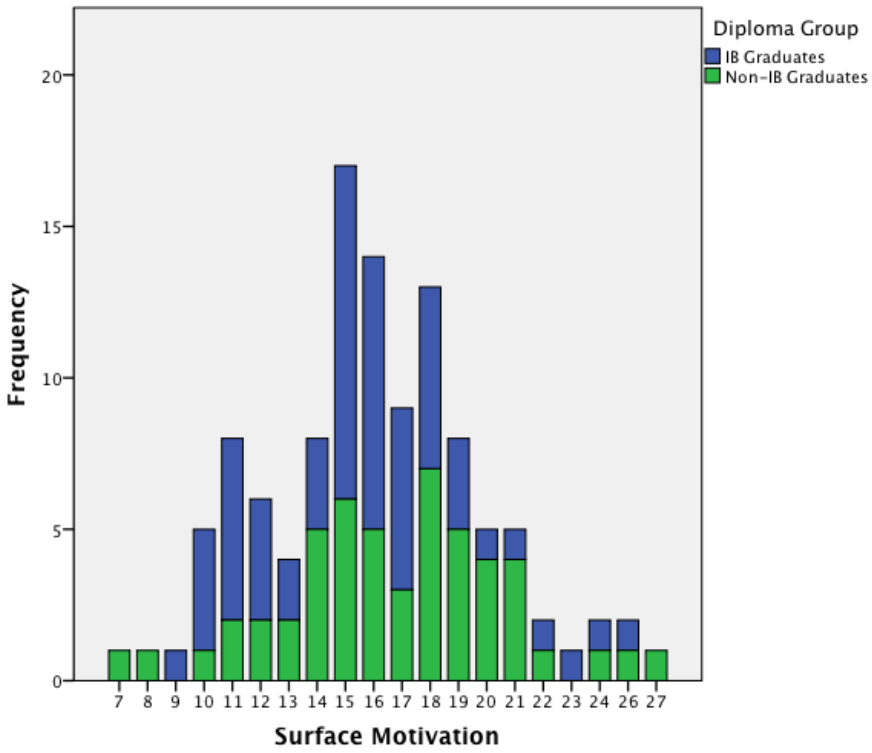
The multivariate test revealed a significant difference between groups ($\Lambda = .925$, $F(6, 105) = 1.418$, $p < .214$, partial $\eta^2 = .075$). The MANOVA had moderate power .532.

Between-subject effects

The table of between-subject effects below shows one significant effect associated with Surface Motivation ($F(1, 110) = 4.542$, $p < .035$, partial $\eta^2 = .040$). Surface Motivation presents a significant difference between the two groups however all the effects are relatively small. Further, powers are weak across all the factors. 1. Surface Motivation had the strongest power (56.1%).

Group distributions

Figure 9
LPQ Factor Surface Motivation group distributions



DISCUSSION

This first research question considers the evidence for what variables best distinguished IB and non-IB schooled undergraduate students in terms of their ratings of the demands of inquiry instruction and learning, epistemic beliefs, and approach to learning. All three of these variables were found to be significantly different using MANOVA statistics.

Ratings of the Importance of Inquiry Demands

An understanding of the nature of effective inquiry instruction and the relative importance of various individual inquiry strategies can only be acquired through deliberate student effort and ample opportunities to engage in inquiry. Therefore the investigator and colleagues developed the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ) to describe students' ratings of the demands of inquiry instruction and learning.

Several articles have been published on the content validity (Shore, et al., 2009) factor validity (Shore, et al., 2012) and construct validity of the McGill Survey of Demands of Inquiry (MSDIQ). Previous research using MSDIQ has principally included Education undergraduate majors seeking pre-service degrees along with psychology undergraduate majors and experienced teachers seeking a Master's of Education degree (MEd), including special training in approaches to teaching inquiry. Because the meaning of the scores on survey instruments are especially sensitive to the nature of the population on which they are normed, a different exploratory factor analysis was carried out using the undergraduate students who could be identified from a sample of 300 as obtaining an International Baccalaureate Diploma before enrolling as undergraduates and a second sample of students who received some other secondary preparation but were accepted into the faculty of Sciences or the faculty of Education. The results of this analysis confirmed 13 of the 14 factors identified in the previous studies.

MSDIQ Results

The MANOVA statistical results show that the IB students assign high overall ratings to the importance of the inquiry instruction and learning demands (MSDIQ Total Score). The overall mean rating score, averaged across all items, ranges between 6.3 and 8.3 on a 10-point Likert scale. It was expected that students would value the importance of the demands that inquiry instruction and inquiring place upon the learner. But, it was also inferred from personal experience across many years of teaching and from a careful reading of several decades of research on the nature of inquiry as a process and inquiry instruction (Aulls, Shore, & Delcourt, 2007, 2008) that some undergraduate students would not have had enough experience as an inquirer, with some students having no formal instruction in how to inquire, how to read research, or how to propose and carry out research. These students could not

be expected to respond more than idealistically or naively to the survey items.

The series of MANOVA results in Table 11 show that, for four factors, significant differences occur between the IB and non-IB students. The IB students rate the importance of demands of inquiry higher than the non-IB students on at least one factor. This is a substantial conceptual difference between the IB trained undergraduate's understanding of the complete process of how to inquire in the classroom with teacher assistance and alone in any context.

Table 11 also indicates the mean ratings associated with the significantly different factor scores for the IB and non-IB students.

Table 11
MSDIQ significant factors

MSDIQ factors	*Factors*	*Significance*	*IB*	*NIB*	*Total*
Generative Strategies	FS2	.036	8.35	7.60	8.00
T&S Co-construction	FS6	.036	7.37	6.39	6.91
Communication	FSDS2	.037	7.67	6.93	7.33
Reflection	FSDSR1	.010	8.08	7.68	7.66

The typical undergraduate (IB and non-IB) rated being generative as the most important factor by assigning it the value of 8.0 on a 10-point scale. An inquirer is generative by: 1) engaging in creative risk taking, 2) allowing oneself to freely engage in imagination, and 3) to contribute suggestions to collaborators.

Reflection (*M* = 7.66) ranked second in ratings of importance assigned by the typical undergraduate student. This is done in a variety of ways including: 1) self-checking as one inquires, 2) discussing and comparing evidence, 3) questioning findings, 4) evaluating findings, 5) following up on issues that arise, 6) explaining results and 7) generating new questions based on old findings. While ideally one might like to isolate strategies for controlling the inquiry process during participation in the extended essay, this research has taken the position that inquiry as the process underlying the EE is a multivariate variable in the natural setting.

The third factor rated as highly important by the students in this sample was Communication of Inquiry results (*M* = 7.33).

The fourth factor was co-construction with the teacher in making a meaningful class environment for learning how to inquire. It was assigned moderate importance rating (*M* = 6.91). Each of these MSDIQ factors occurs during the process of inquiry largely in the classroom in the presence of the instructor and peers.

The four factors were rated in a similar order for the IB students and non-IB students (with only Reflection and Generative Strategies being switched in importance), but the IB student mean scores were higher for each factor.

MSDIQ factor correlations

The correlation between the total score and items from each of the four factors on which IB and non-IB undergraduates were significantly different is one means of representing how each factor contributes to what students value overall as important inquiry dimensions. This section will explore the degree to which individual factors account for the total MSDIQ score. The MSDIQ is organized around three recognized dimensions (Preparation for an Inquiry Project, Enactment of the Inquiry Project, and Reflection on the Enactment). The items on the instrument can be further broken down into 13 factors that share underlying components.

A central part of becoming an inquirer, and engagement in inquiry, is the social dimension of instruction and learning through inquiry. For the communication factor three of the most important strategies measured in this study were: 1) communicating one's learning with others, (rp = .683, p < .001, 2) considering diverse means of communicating (rp = .651, p < .001) and 3) carefully organizing the presentation of project results (rp = .544, p < .001).

The dimensions of cognitive and self-regulatory Reflective inquiry strategies ranked as the most important and included: 1) reflect on the meaningfulness of the inquiry experience (rp = .800, p <. 001), 2) evaluate the inquiry experience (rp = .746, p < .001) and 3) question the findings (rp = .673, p < .001). As we would expect several of these correlations are higher in magnitude than the previous factor.

All three of the inquiry reflective strategies discussed have been mentioned in the National Science Education Standards (*National Science Education Standards*, 1996) policy statements, indicating the most fundamental of the cognitive strategies to scientific inquiry. For example on page 23 of the document:

"Inquiry …involves …posing questions, …reviewing what is already known in light of experimental evidence (results) …communicating the results…."

Stepping back to look at these results conservatively, they show that both non-IB and IB students rate 10 of the factors measured by the MSDIQ in a similar manner. However, the four factors just discussed were rated between fairly important to very important by IB students. Mean differences on the four factors were: 2. Generative Inquiry M = 8.36 (SD = .24) > M = 7.61 (SD = .26) 6. Co-Construction of Inquiry M = 7.38 (SD = .32) > M = 6.40 (SD = .34) 8. Student Inquiry Communication Strategies M = 7.68 (SD = .24) > M = 6.93 (SD = . 26) 13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences M = 8.09 (SD = .24) > M = 7.17 (SD = .26). The IB students rate all four of these factors higher than the non-IB trained students. Each of these factors contributes to one of the three major dimensions of inquiry, as established by the MSDIQ, which would be entailed in

carrying out an EE in the IB DP. Therefore, we consider the multivariate comparison to offer convincing evidence that an undergraduate, who was at one time an IB DP student, perceives important dimensions underlying the dynamic and complex inquiry process differently than non-IB undergraduates.

The approach to learning

Surface motives and Deep motives are two approaches to learning explored using the LPQ. A primary distinction between Surface motives and Deep motives is the goal of learning. Deep learning entails comprehension and other higher order thinking goals (Baeten, Kyndt, Stryven, & Dochy, 2010). Virtually all kinds of inquiry processes demand understanding and utilize deep motives, while Surface motives only demand recall of information and mnemonic strategies of learning. The IB and non-IB students in this study were found to have a statistically significant different Surface Motive score. The IB Diploma Group had $M = 15.46$, $SD = 3.60$ and non-IB had $M = 16.96$, $SD = 3.85$, suggesting IB students are less likely to embrace surface motives for learning since their mean score was lower than non-IB students.

Surface motives are described by Biggs as intending "…to meet academic requirements minimally and to do a balancing act between low performance and working more than is necessary." (Biggs, 1987a, p. 3). He also states "Students show lack of meta learning capabilities when they choose strategies that are incongruent with their motives such as rote learning to satisfy intrinsic curiosity." (Biggs, 1987a, p. 3).

The implications of the preceding results cannot be fully appreciated without being considered in the broader context of the pioneering research on approaches to learning carried out at the tertiary level of education. A "learning approach" was believed to consist of a motive or intention and a strategy or way of learning (Marton & Saljo, 1997). Student approaches to learning were conceived of as a part of the total system in which educational events are located. Ramsden (1984) was one of the earliest higher education researchers to report that classroom environment forms the expectations students hold of instruction and also influences how they prepare for examinations. Therefore, even when students are very good at inquiring, if they are primarily assessed on assessment tools that emphasize memorization, they will memorize rather than attempt to understand what is being studied in a course. Eventually if most courses are like this then their motives for learning and their approach to learning will be at a surface level rather than at a deep level. Indeed even when they are exposed to a course emphasizing inquiry or to an educational environment like the one the extended essay provides, they may perceive that the underlying goal is really to test them on the amount or the accuracy of factual content they present in their written findings.

Many higher education researchers have used Biggs's SPQ and LPQ instruments (Biggs, 1996, 1999) to study learning in higher education settings. Moreover

Entwistle & Waterson, (1988) Entwistle & Ramsden (1983), Biggs, Kember, and Leung (2001), and others have developed survey instruments to assess students' motives and approaches to learning. Generally, these researchers depicted this natural situation in higher education classrooms to be only partly due to what the student knows and does.

Biggs (1993) developed an evaluation model of what happens in classrooms, which included three dimensions: Presage, Process, and Product. The Presage variables are the social, cognitive and emotional knowledge that the student brings to the classroom. He referred to Process variables as context variables such as the content studied, what the teacher does, small group work, activities and the allocation of time to all of these. Biggs gave a special place in his 3 P model to assessment (Product) in the natural setting where formal schooling occurs.

In the United States, Anderson and Burns (1989) set out a similar model depicting learning in classrooms as a function of what the teacher does and the context. For this reason they favored referring to what happens in classrooms as *instruction* not *teaching.* They also point out that a schooling environment where: a) a primary emphasis is on memorization of information for the curriculum tasks and assessment, and/or b) a primary emphasis is on summative evaluation tools that demand memorization to succeed will prioritize memorization as the way for students to generally perform best on school assessments.

There can be different combinations of motives (Surface and Deep) and ways of learning (Surface and Deep) that form a person's overall learning approach. This can get complex as one can be high or low in the surface and the deep motives in combination with a score higher or lower in deep learning strategies. The most efficient approach to learning how to inquire and how to accomplish the EE process would be to hold a deep motive and a deep strategy for inquiring. The least efficient learning approach would be one in which a deep motive is combined with a surface approach or one in which the motive and the strategies are misaligned e.g. holding a surface motive and a deep strategy. Again, Biggs would argue that a valid explanation of why the typical student holds a misaligned learning approach may very well have to do with the learning environment where a teacher uses some misaligned combination of a surface motive and deep approach to instruction as represented in how they assess learning products. These differences may shape student approaches to learning or participation in both the process of instruction and assessment events as much as the actual cognitive strategies the learner holds or learns in a DP or college course.

In this study no significant difference was found in the deep learning approach of IB and non-IB groups but instead a significant difference was found in surface motives for learning. The difference revealed that the IB students had lower surface motive scores than the non-IB students. This result implies that more non-IB students than IB students are likely to come to the university with an unconscious lack of alignment between their motives for learning and their approach to learning.

Epistemic Beliefs

IB students and non-IB students were significantly different on three of the four factors assessed by the SEBQ. Yet they were not significantly different on the Nature of Science measure. These results should not be interpreted as in conflict with each other for several reasons. First the two tests do not measure the same knowledge constructs (as explained in the Rationale and Methodology). The SEBQ is a more general measure of epistemic beliefs while the VNOS-C is a domain specific measure of knowledge relevant to understanding scientific phenomena and arguably carrying out scientific inquiries.

IB and non-IB students appear to be similar in their grasp of the nature of science. However on Schommer's SEBQ test they show statistically significant differences on two factors: 1) Simple Knowledge to which belong the items *Seeks single answers* $M = 2.97$ ($SD = .06$) > $M = 2.71$ ($SD = .11$) and A*voids ambiguity* $M = 3.07$ ($SD = .08$) > $M = 2.68$ ($SD = .14$). The second factor is referred to as a belief in Quick Learning to which the belief that concentrated effort is a waste of time contributes $M = 3.00$ ($SD = .10$) > $M = 2.25$ ($SD = .17$). The non-IB students scored higher on the Five Point Likert scale of the SEBQ than the IB students for both factors. Scoring higher indicates the student is more naïve and confident in their mistaken beliefs and therefore less likely to change that belief. Lower scores are more indicative that a person is more sophisticated and flexible in their beliefs about knowledge and/or in their uses.

Summary

The results relevant to the first research question show triangulation among the measures of: 1) approach to learning, 2) beliefs about knowledge, and 3) perceptions of inquiry self-efficacy as well as of what demands of inquiry are perceived to be the most important. Overall these results consistently suggest that IB graduates have a stronger foundation for undertaking inquiry successfully during undergraduate instruction at the university.

INTRODUCTION: Research Question 3

Research question

What proportion of the variability in the value attributed to inquiry instruction is accounted for by IB schooled and non-IB schooled undergraduates' epistemic beliefs, beliefs about the nature of science, approach to learning, and inquiry self-efficacy?

Variance explained

Instruments

McGill Strategic Demands of Inquiry Questionnaire (**MSDIQ):** (Shore, et al., 2012; Syer, 2007): A 79-item questionnaire with an 11-point Likert scale and 3 subscales: Preparation for an Inquiry Project, 29 items, Enactment of the Inquiry Project, 43 items, Reflection on the Enactment, 5 items. Briefly, exploratory factor analysis results demonstrated that the MSDIQ has 13 factors which can be organized into three dimensions: 1) basic entry level inquiry strategies, 2) the enactment of social and cognitive strategies that must be primarily self-regulated by the student, and 3) inquiry reflective strategies that enable students to improve their ability to deliberately self-regulate the process of inquiry alone.

Schommer-Aikins Epistemic Beliefs Questionnaire (**SEBQ):** (Schommer, 1990; Schommer-Aikins, et al., 2003). This 63-item questionnaire has a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Lower scores represent sophisticated beliefs and higher scores naïve beliefs about knowledge.

Views of Nature of Science Questionnaire (VNOS-C): (Lederman, et al., 2002) consists of 10 open-ended questions designed to probe views of specific aspects of the scientific enterprise. It is validated for use with the intended participants.

Statistical analyses: Multiple regression (1X4 run twice for IB and for non-IB)

Significant results: The two multiple regressions reported below tested how well four measures of inquiry learning predicted inquiry valuing. In other words, how well do beliefs—about epistemology, inquiry self-efficacy, and science—predict how one values the strategic importance of inquiry tasks? The analysis was run twice: first, for IB graduates (n = 34), and second, for non-IB graduates (n = 26). Using IB graduates, the test of the full model with all four predictors was statistically significant ($F(4,29) = 7.234$, $p = .000$). The model accounted for a medium amount of variance (Adjusted $R^2 = .430$) Learning Processes ($\beta = –.018$, $t = –1.637$, $p = .004$) and Views of Science ($\beta = –.003$, $t = –.390$, $p = .011$) were significant predictors of inquiry valuing. Using non-IB graduates, the test of the full model with all four

predictors was also statistically significant (F (4,21) = 4.021, p = .014). The model accounted for a smaller amount of variance (Adjusted R^2 = .326). Learning Processes (β = –.017, t = –1.361, p = .009) and Nature of Science (β = –.009, t = –.637, p = .037) were significant predictors of inquiry valuing.

Comparing the two groups, one notices differential prediction weights for the two groups. For both IB and non-IB graduates, Learning Processes and Views of Science are significant predictors of Inquiry Valuation but they are slightly more important predictors for IB students relative to non-IB students in terms of their predictive power, i.e. the amount of variance accounted for.

The Biggs Learning Process Questionnaire (LPQ): (Biggs, 1987a,1987c). This is a 42-item questionnaire designed to measure approaches to learning. The LPQ has six scales, which measure Surface Motive, Surface Strategies, Deep Motive, Deep Strategies, Achieving Motive and Achieving Strategies, each with seven items.

The Inquiry Self-Efficacy Survey (SDEIQ): (Aulls & Shore, 2010). This 69-item instrument is designed to estimate students' confidence in accomplishing inquiry tasks and situations arising when inquiry is engaged in any setting and in formal education settings.

RESULTS

The analysis was run twice: first, for IB graduates, and second, for non-IB graduates. For the IB undergraduates, the test of the full model with all four predictors was statistically significant ($F(4,29) = 7.234$, $p = .000$). As reported in Table 31, the model accounted for a medium amount of variance (Adjusted $R^2 = .430$).

Table 31
Model summary

Model	*R*		*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*	*Durbin-Watson Statistic*	
	IB Graduates (Selected)	Non-IB Graduates (Unselected)				IB Graduates (Selected)	Non-IB Graduates (Unselected)
1	.707	.435	.499	.430	.59456	1.977	1.482

Table 32
ANOVA results

Model		*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
1	Regression	10.229	4	2.557	7.234	.000
	Residual	10.251	29	.353		
	Total	20.481	33			

As can be seen in Table 33 below, Learning Processes ($\beta = -.018$, $t = -1.637$, $p = .004$) and Views of Science ($\beta = -.003$, $t = -.390$, $p = .011$) were significant predictors of the importance attributed overall to inquiry instruction and learning.

Table 33
Regression coefficients

Model		*Unstandardized Coefficients*		*Standardized Coefficients*	*t*	*Sig.*
		B	Std. Error	Beta		
1	(Constant)	8.701	2.938	2.961	14.711	
	Epistemological Beliefs	–.363	.396	–.140	–.915	.448
	Inquiry Self-Efficacy	.376	.116	.530	3.241	.613
	Learning Processes	–.018	.011	–.299	–1.637	.004
	Views of Science	–.003	.007	–.052	–.390	.011

Table 34
Residuals statistics

	IB Graduates (Selected)					*Non-IB Graduates (Unselected)*		
	Min	Max	Mean	Std. Dev.	N	Min	Max	Mean
Predicted Value	6.849	8.948	8.082	.557	34	6.658	9.056	8.054
Residual	–1.141	1.210	.00000	.557	34	–2.142	2.364	–.280
Std. Predicted Value	–2.214	1.556	.000	1.000	34	–2.558	1.750	–.051
Std. Residual	–1.920	2.035	.000	.937	34	–3.602	3.976	–.469

Non-IB graduates' epistemological beliefs, inquiry self-efficacy, learning processes and views of science on inquiry value — multiple regression

For the non-IB undergraduates, the test of the full model with all four predictors was also statistically significant ($F(4,21) = 4.021$, $p = .014$). As reported in table 35, the model accounted for a smaller amount of variance than for the IB group (Adjusted $R^2 = .326$).

Table 35
Model summary

Model	*R*		*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*	*Durbin-Watson Statistic*	
	Non-IB Graduates (Selected)	IB Graduates (Unselected)				Non-IB Graduates (Selected)	IB Graduates (Unselected)
1	.659	.523	.434	.326	.771	1.743	1.278

Table 36
ANOVA results

Model		*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
1	Regression	9.565	4	2.391	4.021	.014
	Residual	12.488	21	.595		
	Total	22.053	25			

As can be seen in Table 37, Learning Processes ($\beta = –.017$, $t = –1.361$, $p = .009$) and Views of Science ($\beta = –.009$, $t = –.637$, $p = .037$) were again significant predictors of the total importance assigned by the non-IB graduates to inquiry instruction and learning.

Table 37
Regression coefficients

Model		*Unstandardized Coefficients*		*Standardized Coefficients*	*t*	*Sig.*
		B	Std. Error	Beta		
1	(Constant)	1.932	7.214		.268	16.933
	Epistemological Beliefs	.570	1.014	.166	.562	2.678
	Inquiry Self-Efficacy	.447	.187	.447	2.395	.836
	Learning Processes	–.017	.013	–.315	–1.361	.009
	Views of Science	.009	.014	.152	.637	.037

Table 38
Residuals statistics

	Non-IB Graduates (Selected)					*IB Graduates (Unselected)*		
	Min	Max	Mean	Std. Dev.	N	Min	Max	Mean
Predicted Value	6.247	8.465	7.446	.619	26	5.784	8.930	7.450
Residual	–1.447	1.375	.000	.707	26	–1.257	2.915	.588
Std. Predicted Value	–1.938	1.648	.000	1.000	26	–2.685	2.400	.007
Std. Residual	–1.876	1.783	.000	.917	26	–1.629	3.780	.763

	IB Graduates (Unselected)	
	Std. Dev.	N
Predicted Value	.70	72
Residual	.83	72
Std. Predicted Value	1.13	72
Std. Residual	1.08	72

DISCUSSION

What proportion of the total variability in the importance attributed to inquiry strategies is accounted for by IB schooled and non-IB schooled undergraduates' epistemic beliefs, beliefs about the nature of science, approach to learning, and inquiry self-efficacy?

The two multiple regressions reported below tested how well the four variables above predicted the overall value (or importance) attributed to inquiry instruction and learning by IB graduates and non-IB graduates. In other words, how well do learning approaches, epistemic beliefs, inquiry self-efficacy, and knowledge of science predict the total rating of importance assigned to all the demands of inquiry instruction and learning the students rated? The analysis was run twice: first, for IB graduates, and second, for non-IB graduates. For the IB DP undergraduates, the test of the full model with all four predictors was statistically significant ($F(4,29) = 7.234$, $p = .000$). The model accounted for a medium amount of variance (Adjusted $R^2 = .430$). Learning Approaches ($\beta = -.018$, $t = -1.637$, $p = .004$) and Views of Science ($\beta = -.003$, $t = -.390$, $p = .011$) were significant predictors of the importance attributed over all to inquiry instruction and learning.

For the non-IB undergraduates, the test of the full model with all four predictors was also statistically significant ($F(4,21) = 4.021$, $p = .014$). The model accounted for a smaller amount of variance than for the IB group (Adjusted $R^2 = .326$). Learning Approach ($\beta = -.017$, $t = -1.361$, $p = .009$) and the knowledge of the nature of science ($\beta = -.009$, $t = -.637$, $p = .037$) were again significant predictors of the total importance assigned by the typical college student to inquiry instruction and learning.

Forty-three percent of the variability in the overall value students assigned to inquiry instruction and learning could be accounted for by the students approach to learning and their views of the nature of science. Approach to Learning has been widely studied by researchers in higher education and secondary school for two decades. It has been found to account for the variability in a variety of variables.

Because the same variables accounted for the variability in IB and non-IB undergraduates' ratings of the importance of demands of inquiry, it is suggested the stability of their contribution is high. There were no significant differences in the VNOS-C scores measuring knowledge of the nature of science variables when IB and non-IB students were compared. Comparison of the beta weights shows that approaches to learning accounts for far more of the variability in value of inquiry than knowledge of the nature of science. Although several variables measured by VNOS-C, if treated as single variables, would have been significant. Finally this comparison also indicates that Approach to Learning accounts for more variance in the IB students valuing of inquiry than the non-IB student. The IB student has a slightly less naive surface motive and the non-IB student has a slightly deeper

approach to learning. Both have patterns of learning approaches that show that they may be slow to change their learning approach during innovative student centered instruction. (See Research Question two, e.g., IB students approach to learning was found to be one of a moderately surface motive for learning and moderately deep approach to learning). The strongest inference warranted for the results of question six is that the students' who have a moderate to strong deep approach are also likely to value the importance of inquiry and participation in it. Thus, IB instruction is more strongly related than non-IB to the views of science and learning approaches students take.

INTRODUCTION: Research Question 4

Research question

Does a significant relationship exist between the kind of schooling a student receives and their subsequent value of inquiry and inquiry instruction? What proportion of the variability in the importance attributed to inquiry strategies, as ranked as important by experts, is accounted for by IB schooled and non-IB schooled undergraduates' inquiry self-efficacy, epistemic beliefs, approach to learning, and beliefs about the nature of science?

Variance explained

Instruments

McGill Strategic Demands of Inquiry Questionnaire (**MSDIQ):** (Shore, et al., 2012; Syer, 2007): A 79-item questionnaire with an 11-point Likert scale and 3 subscales: Preparation for an Inquiry Project, 29 items (.93), Enactment of the Inquiry Project, 43 items (.96), Reflection on the Enactment, 5 items (.90). Briefly, exploratory factor analysis results demonstrated that the MSDIQ has 13 factors which can be organized into three dimensions: 1) basic entry level inquiry strategies, 2) the enactment of social and cognitive strategies that must be primarily self-regulated by the student, and 3) inquiry reflective strategies that enable students to improve their ability to deliberately self-regulate the process of inquiry alone.

The Inquiry Self-Efficacy Survey (**SDEIQ):** (Aulls & Shore, 2010). This 69-item instrument is designed to estimate students' confidence in accomplishing inquiry tasks and situations arising when inquiry is engaged in any setting and in formal education settings. It is divided into seven subscales: Interpretation and Presentation of Results (15 items), Domain General Strategies, (12 items), Data Analysis (11 items), Self-regulatory Strategies (10 items), Classroom Cooperation Behaviors During Inquiry Instruction (7 items), Inquiry Disposition (3 items), and Inquiry Small Group Collaboration Behaviors (10 items).

Schommer-Aikins Epistemic Beliefs Questionnaire (**SEBQ):** (Schommer, 1990; Schommer-Aikins, et al., 2003). This 63-item questionnaire has a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Lower scores represent sophisticated beliefs and higher scores naïve beliefs about knowledge.

The Biggs Learning Process Questionnaire (LPQ): (Biggs, 1987a, 1987c). This is a 42-item questionnaire designed to measure approaches to learning. The LPQ has six scales, which measure Surface Motive, Surface Strategies, Deep Motive, Deep Strategies, Achieving Motive and Achieving Strategies, each with seven items.

Views of Nature of Science Questionnaire (VNOS-C): (Lederman, et al., 2002) consists of 10 open-ended questions designed to probe views of specific aspects of the scientific enterprise.

RESULTS

Statistical analyses: χ^2 Contingency table, Logistic regression (1X4 run twice for IB and for non-IB)

Significant results: A significant relationship exists between type of secondary schooling and the value university students assign overall to the importance of inquiry instruction. The results show that more IB students than non-IB students place a high value on inquiry instruction. A chi-square test for Diploma Group X Inquiry Valuing χ^2 (1, 4.426, p = .035) was run. Given the results of the Chi-Square test, an exploratory statistical analysis was carried out in an attempt to determine more precisely whether epistemological beliefs, beliefs about the nature of science, approaches to learning or inquiry self-efficacy could account for the value attributed to inquiry instruction and learning by the IB and non-IB groups.

The logistic regression uses maximum likelihood estimation (MLE) of the log-odds ratios to place cases in one or the other group. It is appropriate to talk about the likelihood of the dependent variable based on the combined probabilities of the independent variables. Logistic regression requires large n (>400) in order to make accurate predictions (Bewick, Cheek, & Ball, 2005); error is inflated when n is small. Since this study doesn't have the recommended number of cases, the results to be reported can only be considered exploratory and provisional but could offer other researchers new insights for designing future studies.

The analysis was done first for IB graduates, and then again, for non-IB graduates. For IB graduates, the test of the full model with all four predictors against the constant-only model was statistically significant, χ^2(4, 14.668, p = .005) indicating that the group of predictors reliably identified the high valuing inquiry group. The variance accounted for is small, Nagelkerke R^2 = .482. Classification is poor, 58.3% low inquiry, 86.4% high inquiry, and 76.5% overall. The Wald criterion provides an estimation of the significance of the weighted contribution of each variable to the overall prediction of group membership. Inquiry self-efficacy is a significant estimator of the value assigned to the importance of inquiry demands (W = 3.955, p = .047). The exponential function of the coefficients provides an estimate of the log-odds ratios for each of the predictors; for every one unit increase in learning processes, the probability of being a high inquirer increases by x%. Inquiry self-efficacy and inquiry valuation are at 2.803:1.

In the second analysis for non-IB students, the test of the full model with all four predictors against the constant-only model was also statistically significant, χ^2(4,

10.062, $p = .039$) indicating that the group of predictors reliably distinguished between the high and low inquiry groups. The variance accounted for is small, Nagelkerke $R^2 = .443$. Classification is relatively good, 88.2% low inquiry, 77.8% high inquiry, and 84.6% overall. The Wald criterion provides an estimation of the significance of the weighted contribution of each variable to the overall prediction of group membership. In this case, none of the variables is a significant estimator of inquiry valuation.

Comparing the IB and non-IB regression results, for only IB trained undergraduates, inquiry self-efficacy is a significant predictor of inquiry valuing for IB students. Specifically, inquiry self-efficacy is a significant predictor of membership in the IB group that places a high value on inquiry demands. For non-IB graduates, none of the four predictors was significant.

The table below lists the expected frequencies for group membership in either the low or the high Inquiry Valuing groups. Inquiry Valuing was determined by dichotomizing the total scores for MSDIQ using a mean split to create the two groups. As can readily be seen, there are a greater number of IB graduates valuing inquiry than would normally be expected and the converse is true for non-IB graduates, who do not value inquiry to the same extent.

Table 12
Chi-square table

			Inquiry Valuing		*Total*
			Low	1.00	
Diploma Group	IB	Count	20	29	49
		Expected Count	25.0	24.0	49.0
	Non-IB	Count	27	16	43
		Expected Count	22.0	21.0	43.0
Total		Count	47	45	92
		Expected Count	47.0	45.0	92.0

The Pearson Chi-Square test was significant $\chi^2(1, 4.426, p = .035)$. This suggests that there exists a significant difference in our grouping variable, Diploma Group, on the dependent variable, Inquiry Valuing.

Table 13
Chi-square tests

	Value	*df*	*Asymp. Sig. (2-sided)*	*Exact Sig. (2-sided)*	*Exact Sig. (1-sided)*
Pearson Chi-Square	4.426 [a]	1	.035		
Likelihood Ratio	4.464	1	.035		
Fisher's Exact Test				.040	.029
Linear-by-Linear Association	4.378	1	.036		
N of Valid Cases	92				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 21.03.

There were 92 valid cases out of 265 potential cases (34.7%). Cases were eliminated for incomplete data. This is largely due to the fact that not all respondents in the convenience sample completed the surveys requested of them.

IB Graduates Logistic Regression

A logistic regression was run twice, once for each group, the IB graduates and the non-IB graduates. The first logistic regression included 34 cases.

Block 0: Beginning Block

In logistic regression, a first constant-only model is tested to see if it is sufficient to predict group membership. In this case, while overall classification was greater than chance (64.7%), the model did not significantly predict group membership on Inquiry Valuing $\chi^2(1, 2.853, p = .091)$. Table 16 shows how the addition of at least two variables would significantly change the model's predictive power, so the analysis proceeded with a second logistic regression using a full model with all four predictors, Inquiry Self-Efficacy, Epistemological Beliefs, Learning Processes, and Views of Science.

Table 14

Classification table

	Observed		*Predicted*					
			Selected Cases			Unselected Cases		
			Inquiry Value		Percentage	Inquiry Value		Percentage
			Low	High	Correct	Low	High	Correct
	Inquiry	Low	0	12	.0	0	34	.0
Step 0	Value	High	0	22	100.0	0	30	100.0
	Overall Percentage				64.7			46.9

Table 15

Variables in the equation

		B	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*
Step 0	Constant	.606	.359	2.853	1	.091	1.833

Table 16

Variables not in the equation

			Score	*df*	*Sig.*
Step 0	Variables	Inquiry Self-Efficacy	11.370	1	.001
		Epistemological Beliefs	.251	1	.617
		Learning Processes	7.823	1	.005
		Views of Science	.0750	1	.784
	Overall Statistics		12.942	4	.012

Block 1: Method = Enter

As can be seen in Table 17 below, the full model is statistically significant $\chi^2(4, 14.668, p = .005)$, which means that the four-variable model can reliably identify membership in the high Inquiry Valuing group.

Table 17
Omnibus tests of model coefficients

		Chi-square	*df*	*Sig.*
Step 1	Step	14.668	4	.005
	Block	14.668	4	.005
	Model	14.668	4	.005

The variance accounted for is small, Nagelkerke $R^2 = .482$. The Hosmer and Lemeshow test is a goodness-of-fit test. The test did not reveal a statistical difference, so the model is an adequate fit. Classification (Table 20) is poor, 58.3% low inquiry, 86.4% high inquiry, and 76.5% overall.

Table 18
Model summary

Step	*-2 Log likelihood*	*Cox & Snell R Square*	*Nagelkerke R Square*
1	29.481	.350	.482

Table 19
Hosmer and Lemeshow test

Step	*Chi-square*	*df*	*Sig.*
1	6.200	8	.625

Table 20
Classification table

	Observed		*Predicted*					
			Selected Cases			Unselected Cases		
			Inquiry Value		Percentage	Inquiry Value		Percentage
			Low	High	Correct	Low	High	Correct
Step 1	Inquiry Value	Low	7	5	58.3	13	21	38.2
		High	3	19	86.4	5	25	83.3
	Overall Percentage				76.5			59.4

The Wald criterion provides an estimation of the significance of the weighted contribution of each variable to the overall prediction of group membership. Inquiry self-efficacy is a significant estimator of the value assigned to the importance of inquiry demands ($W = 3.955$, $p = .047$). The exponential function of the coefficients provides an estimate of the log-odds ratios for each of the predictors; for every one unit increase in learning processes, the probability of being a high inquirer increases by *x*%. Inquiry self-efficacy and inquiry valuation are at 2.803:1.

Table 21
Variables in the Equation

		B	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I.for EXP(B)*	
								Lower	Upper
Step 1	Inquiry Self-Efficacy	1.031	.518	3.955	1	.047	2.803	1.015	7.742
	Epistemological Beliefs	-.876	2.051	.182	1	.669	.416	.007	23.199
	Learning Processes	-.075	.053	2.004	1	.157	.928	.837	1.029
	Views of Science	.000	.033	.000	1	.993	1.000	.937	1.068
	Constant	3.078	13.165	.055	1	.815	21.706		

Non-IB Graduates Logistic Regression

A logistic regression was run twice, once for each Diploma Group, the IB graduates and the non-IB graduates. The second logistic regression for non-IB graduates included 26 cases.

Table 22
Number of cases included in the analysis

Unweighted Cases		*N*	*Percent*
Selected Cases	Included in Analysis	26	3.8
	Missing Cases	73	10.7
	Total	99	14.5
Unselected Cases		585	85.5
Total		684	100.0

Block 0: Beginning Block

In logistic regression, a first constant-only model is tested to see if it is sufficient to predict group membership. In this case, while overall classification was greater than chance (65.4%), the model did not significantly predict group membership on Inquiry Valuing $\chi^2(1, 2.380, p = .123)$. Table 25 shows how the addition of at least two variables would significantly change the model's predictive power, so the analysis proceeded with a second logistic regression using a full model with all four predictors, Inquiry Self-Efficacy, Epistemological Beliefs, Learning Processes, and Views of Science.

Table 23
Classification table

	Observed		*Predicted*					
			Selected Cases			Unselected Cases		
			Inquiry Value		Percentage	Inquiry Value		Percentage
			Low	High	Correct	Low	High	Correct
	Inquiry	Low	17	0	100.0	29	0	100.0
Step 0	Value	High	9	0	.0	43	0	.0
	Overall Percentage				65.4			40.3

Table 24
Variables in the equation

		B	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*
Step 0	Constant	-.636	.412	2.380	1	.123	.529

Table 25
Variables not in the equation

			Score	*df*	*Sig.*
Step 0	Variables	Inquiry Self-Efficacy	.712	1	.399
		Epistemological Beliefs	4.870	1	.027
		Learning Processes	6.177	1	.013
		Views of Science	2.598	1	.107
	Overall Statistics		8.575	4	.073

Block 1: Method = Enter

As can be seen in Table 26 below, the full model is statistically significant $\chi^2(4, 10.062, p = .039)$, which means that the four-variable model can reliably identify membership in the high Inquiry Valuing group.

Table 26
Omnibus tests of model coefficients

		Chi-square	*df*	*Sig.*
Step 1	Step	10.062	4	.039
	Block	10.062	4	.039
	Model	10.062	4	.039

The variance accounted for is small, Nagelkerke $R^2 = .443$. The Hosmer and Lemeshow test is a goodness-of-fit test. The test did not reveal a statistical difference so the model is an adequate fit. Classification (Table 29) is relatively good, 88.2% low inquiry, 77.8% high inquiry, and 84.6% overall.

Table 27
Model summary

Step	*-2 Log likelihood*	*Cox & Snell R Square*	*Nagelkerke R Square*
1	23.480a	.321	.443

Table 28
Hosmer and Lemeshow test

Step	*Chi-square*	*df*	*Sig.*
1	12.771	7	.078

Table 29
Classification table

	Observed		*Predicted*					
			Selected Cases			Unselected Cases		
			Inquiry Value		Percentage	Inquiry Value		Percentage
			Low	High	Correct	Low	High	Correct
Step 1	Inquiry Value	Low	15	2	88.2	27	2	93.1
		High	2	7	77.8	28	15	34.9
	Overall Percentage				84.6			58.3

The Wald criterion provides an estimation of the significance of the weighted contribution of each variable to the overall prediction of group membership. In this case, none of the variables is a significant estimator of inquiry valuation.

Table 30
Variables in the equation

		B	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I.for EXP(B)*	
								Lower	Upper
Step 1	Inquiry Self-Efficacy	.571	.634	.809	1	.368	1.769	.510	6.134
	Epistemological Beliefs	1.112	3.106	.128	1	.720	3.042	.007	1339.119
	Learning Processes	-.065	.045	2.143	1	.143	.937	.858	1.022
	Views of Science	-.053	.048	1.204	1	.273	.949	.864	1.042
	Constant	10.270	22.611	.206	1	.650	28845.347		

DISCUSSION

Initially, this study explored what kind of secondary schooling was related to undergraduates valuing of inquiry instruction and learning.

To answer this question it was first determined whether schooling was related to valuing of inquiry instruction and learning by comparing the non-IB undergraduates and the IB undergraduates on the MSDIQ ratings. The results indicate that the kind of secondary schooling was significantly related to ratings of the value of inquiry instruction.

To further pursue this initial finding, we attempted to determine for each group separately whether beliefs about knowledge and the nature of science as well as approach to learning and inquiry self-efficacy could predict the membership in a high or low rating of the value of inquiry instruction. To test this logistic regression analysis using odds ratios was used. An odds ratio (OR) is the odds of the outcome in one group divided by the odds of the outcome in a second group. As a ratio it ranges from zero to infinity (Grimes & Schulz, 2008). The odds ratio also offers an estimate of the strength of association: Strong (OR > 3), moderate (OR = 1.6–3.0), and weak (OR = 1.1–1.5). Hopkins (2002) estimates that the odds ratio of 3.0 between self-efficacy and a high rating of inquiry instruction and learning of the value of inquiry instruction and learning is equal to a correlation of approximately .30.

Thus, the odds ratio in the IB sample of undergraduates shows a moderate relationship between inquiry self-efficacy and membership in the high valuing of inquiry group. None of the variables were significant predictors for the non-IB group.

Inquiry self-efficacy has a moderate association to IB students' value of inquiry instruction and learning demands. It does not enter at all into the model for the non-IB students. This pattern suggests that the confidence the IB trained undergraduates in this study hold in how to accomplish the inquiry instruction and learning best predicts membership in the group of IB students who rate inquiry instruction as very important. Students who attend other forms of secondary schooling where the EE is not a major academic requirement simply do not rate Inquiry instruction and learning as being highly valued. This is a very strong outcome supporting the impact of IB schooling compared to those who do not necessarily get a systematic and extended opportunity to engage in research and inquiry more broadly.

INTRODUCTION: Research Question 5

Research question

Is there a significant difference between epistemic beliefs of pre-service teachers graduating from IB DP schooling compared to non-IB pre-service teachers?

Significant results

Instrument: This 63-item SEBQ (Schommer, 1990; Schommer-Aikins, et al., 2003) has a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Lower scores represent sophisticated beliefs and higher scores naïve beliefs about knowledge.

Statistical analyses: 2X1 ANOVA, 2X12 MANOVA

Significant results: No significant result was obtained for the SEBQ ANOVA. The SEBQ MANOVA was ($\Lambda = .857$, $F(12, 58) = 4.142$, $p = .000$, $\eta^2 = .461$). Between-subject effects below showed that factors 1, 3, and 12 present significant differences (1. Seek Single Answers $F(1,69) = 4.420$, $p = .039$, partial $\eta^2 = .060$), 3. Avoid Ambiguity ($F(1, 69) = 6.035$, $p = .017$, $\eta^2 = .080$), 12. Concentrated Effort ($F(1, 69) = 14.577$, $p = .000$, $\eta^2 = .174$).)

SEBQ mean differences

Seek Single Answers $M = 2.97$ ($SD = .06$) > $M = 2.71$ ($SD = .11$)
Avoid Ambiguity $M = 3.07$ ($SD = .08$) > $M = 2.68$ ($SD = .14$)
Concentrated Effort $M = 3.00$ ($SD = .09$) > $M = 2.25$ ($SD = .17$)

RESULTS

SEBQ MANOVA

Descriptive statistics

For the SEBQ MANOVA, group 1 included 55 IB graduates and group 2 included 16 non-IB graduates.

The means and standard deviations for the IB and non-IB as well as the totals for each factor are listed in Table 39. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Table 39
SEBQ descriptive statistics

	Diploma Group	*Mean*	*Std. Deviation*	*N*
Seek Single Answers	IB	2.97	.44	55
	Non-IB	2.71	.45	16
	Total	2.91	.45	71
Avoid Integration	IB	3.01	.41	55
	Non-IB	2.85	.42	16
	Total	2.98	.42	71
Avoid Ambiguity	IB	3.07	.53	55
	Non-IB	2.68	.68	16
	Total	2.98	.58	71
Knowledge Certain	IB	2.85	.46	55
	Non-IB	2.89	.58	16
	Total	2.86	.49	71
Depend Authority	IB	2.78	.64	55
	Non-IB	2.98	.48	16
	Total	2.82	.61	71
Don't Criticize Authority	IB	2.65	.43	55
	Non-IB	2.63	.38	16
	Total	2.64	.41	71
Ability Learn	IB	2.53	.62	55
	Non-IB	2.34	.63	16
	Total	2.49	.63	71
Can't Learn How to Learn	IB	3.71	.53	55
	Non-IB	3.58	.49	16
	Total	3.68	.52	71
Success Not Hard Work	IB	3.52	.51	55
	Non-IB	3.28	.64	16
	Total	3.46	.55	71

Learn First Time	IB	2.78	.47	55
	Non-IB	2.50	.57	16
	Total	2.71	.50	71
Learn Quick	IB	2.79	.35	55
	Non-IB	2.96	.46	16
	Total	2.83	.38	71
Concentrated Effort	IB	3.00	.68	55
	Non-IB	2.25	.73	16
	Total	2.83	.76	71

Test of assumptions

Neither Box's test of equality of covariance matrices nor Levene's tests of equality of error variances was significant (See Appendix), suggesting that the assumptions of the homogeneity of variances-covariances are tenable.

Multivariate test

The multivariate test revealed a significant difference between groups ($\Lambda = .857$, $F(12, 58) = 4.142$, $p < .000$, partial $\eta^2 = .461$). The MANOVA had strong power .998.

The table of between-subject effects below shows that factors 1. Seek Single Answers ($F(1,69) = 4.420$, $p = .039$, partial $\eta^2 = .060$), 3. Avoid Ambiguity ($F(1,69) = 6.035$, $p = .017$, partial $\eta^2 = .080$), and 12. Concentrated Effort is a Waste of Time ($F(1,69) = 14.577$, $p = .000$, partial $\eta^2 = .174$) present significant differences between the two groups however all the effects are relatively small. Observed power for each factor was relatively weak. Factors 1 (54.5%), 3 (67,8%), and 12 (96.4%) represent the variables with the greatest effect size and the strongest power.

Group distributions

Figure 10. SEBQ Factor #1 Seek Single Answers group distributions

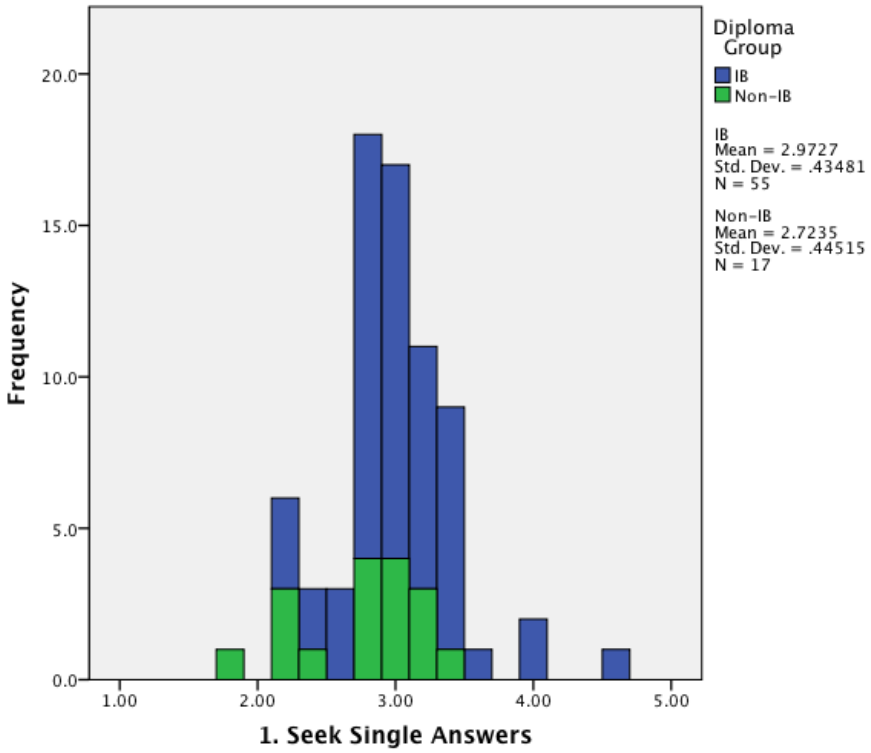


Figure 11. SEBQ Factor #3 Avoids Ambiguity group distributions

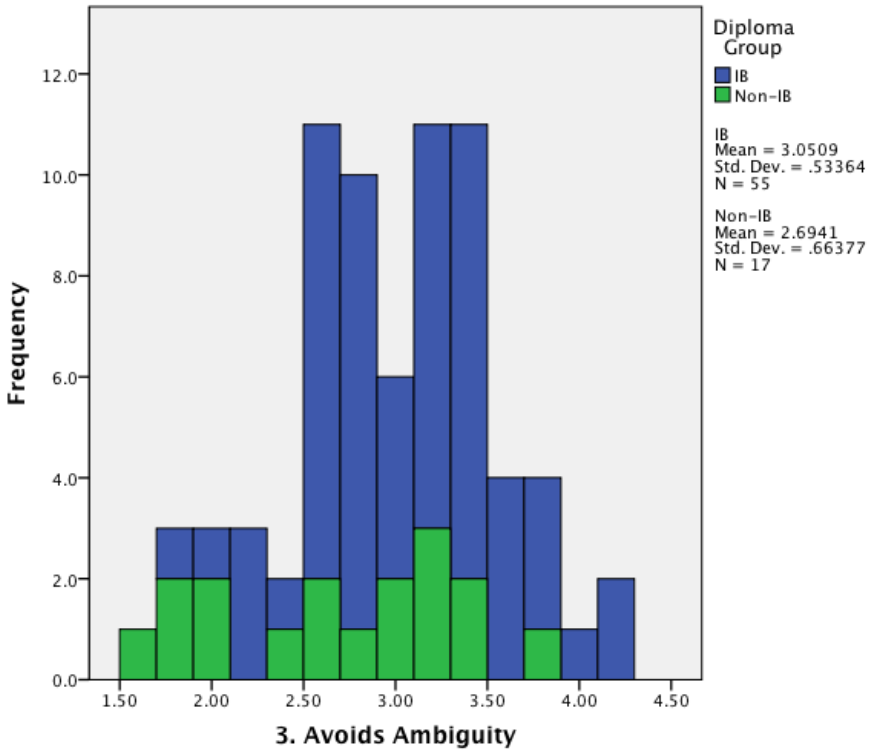
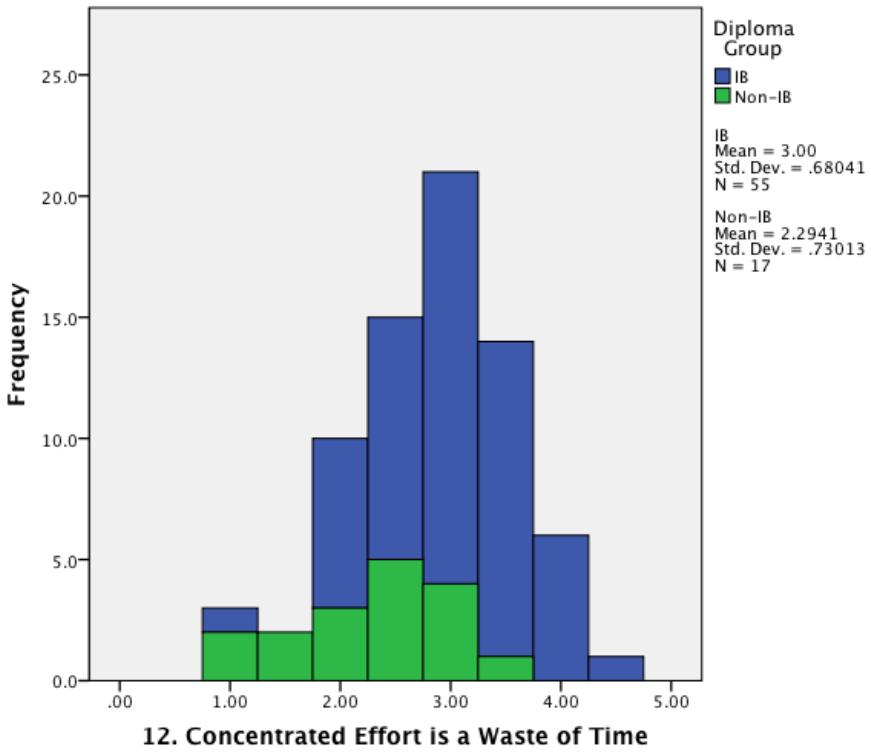


Figure 12. SEBQ Factor #12 Concentrated Effort is a Waste of Time group

distributions



DISCUSSION

This research question seeks to determine if there is evidence of a significant difference between the kinds of general epistemic beliefs of pre-service teachers graduating from IB schooling compared to non-IB schooled pre-service teachers. Between-subject effects showed that 3 items present significant differences: 1) Seek Single Answers $F(1,69) = 4.420$, $p = .039$, partial $\eta^2 = .060$), 2) Avoid Ambiguity ($F(1, 69) = 6.035$, $p = .017$, $\eta 2 = .080$), and 3) Concentrated Effort ($F(1, 69) = 14.577$, $p = .000$, $\eta^2 = .174$). The means and standard deviations were: Seek Single Answers $M = 2.97$ ($SD = .06$) > $M = 2.71$ ($SD = .11$). Avoid Ambiguity $M = 3.069$ ($SD = .08$) > $M = 2.68$ ($SD = .14$) and Concentrated Effort $M = 3.000$ ($SD = .09$) > $M = 2.25$ ($SD = .17$). These results are in contrast to those in Research Question 2 comparing all IB trained undergraduate students from education and the sciences. It was found in the analysis of research question 2 that IB students' epistemic beliefs were more sophisticated than non-IB students. To the contrary, research question five results show that non-IB undergraduates hold three different epistemic beliefs, which are more sophisticated than the IB students. How does one explain such results?

First in both research questions different epistemic belief items are being assessed. However, the belief factor of Simple knowledge occurs as a significant difference when all undergraduates with IB schooling are compared to all non-IB undergraduates and when IB and non-IB Education majors are compared. It is one of the epistemic beliefs that has been empirically found to affect strategies also relevant to doing inquiry.

Second, the 6 belief items are associated with 3 of the 4 belief factors that Schommer's questionnaire measures: 1) Simple knowledge (3 items), 2) Quick learning (1 item) and 3) Certain Knowledge (2 item). The SEBQ's fourth factor is Fixed Ability and IB and non-IB trained students performed similarly on these belief items. Since Simple Knowledge is the one common belief factor it would appear that undergraduates majoring in Education may not benefit as much as Science majors from IB experiences in ways that lead to sophisticated rather than naïve beliefs about the nature of knowledge. Furthermore, this difference might have implications for the reconsideration of the design of the required theory of knowledge course. Most of the forms of epistemic beliefs above have been shown empirically to have relationships to learning strategies often used during inquiry. For example, belief in Simple Knowledge factors is related to the overuse of rehearsal strategies (Dahl, et al., 2005; Phan, 2008). Dahl et al. (2005) studied business administration and education undergraduates' beliefs about knowledge and found that simple knowledge was one factor that significantly predicted reports of strategy use. Studies which focus on the direct effect of epistemic beliefs on strategy use can be seen under three categories: those which focus on frequency (extent) of strategy use (Bråten & Strømsø, 2005; Phan, 2008), those which focus on depth of strategy use (Chan, 2007; Ravindran, et al., 2005) and those which focus on specific strategy uses (Dahl, et al., 2005; Schommer-Aikins & Easter, 2008).

In addition to students' extent of strategy use, epistemic beliefs are also related to the depth of strategies students use. In Chan's (2007) study, 231 (59 male, 158 female) pre-service teacher education students were given: a) the Epistemological Beliefs Scale (Chan & Elliott, 2004) which measures beliefs about authority/expert knowledge, certainty, innate/fixed ability and learning effort/process, and b) the Revised two Factor Study Process Questionnaire (R-SPQ-2F) (Biggs, et al., 2001) measuring deep strategy and surface strategy uses. Path analysis results indicated that the more students believe in authority/experts as a source of knowledge, certainty of knowledge and innate/fixed ability the more likely they adopt surface strategies. On the other hand, belief in learning effort/process was related to deep strategy. Two dimensions of cognitive engagement (meaningful and shallow) were measured using the subscale items of Motivation and Strategy use survey (Greene & Miller, 1996). Regression analyses of each of the cognitive engagement dimensions on the five belief measures indicated that belief in omniscient authority and certain knowledge predicted meaningful cognitive engagement. The more students believed in authority as a source of knowledge, the less they engaged cognitively in a meaningful way. However, it was also found that the less students believed that knowledge is certain, the less they engaged meaningfully. The authors recommended further investigation to better understand this relationship. On the other hand, as belief in simple knowledge predicted shallow cognitive engagement. Students who believed that knowledge is simple were more likely to engage in shallow processing. This result seems to support the overall results combining IB Education and Science majors.

Dahl et al (2005) administered the Norwegian versions of Schommer's Questionnaire (measuring beliefs on simple knowledge, fixed ability, quick learning and certain knowledge) and MSLQ (measuring rehearsal, elaboration, critical thinking, organization and meta-cognitive self-regulation strategies) to 81 (21 male, 60 female) undergraduate students. Separate regression analyses to see the prediction of each strategy from the belief dimensions have shown that beliefs in simple knowledge and fixed ability had better prediction of strategy use than beliefs about quick learning and certainty of knowledge. Naïve belief about knowledge organization (knowledge is simple) indicated more of a tendency to use rehearsal strategies and less of a tendency to use organization and meta-cognitive strategies. Also, a belief that knowledge is a fixed entity indicated a lower likelihood of using elaboration, critical thinking and meta-cognitive strategies.

Schommer-Akins and Easter (2008) also studied whether differences in the use specific strategies can be explained by epistemic beliefs, epistemologically related beliefs and gender. The study was conducted on 264 college (151 junior and 113 senior) students. Kardash's Epistemological Beliefs Scale which measures the dimensions of speed of knowledge acquisition, structure of knowledge, knowledge construction & modification, characteristic of successful students, and attainability of truth was used in the study. Regression analyses of epistemic beliefs as predictors of strategy use revealed significant results for speed of knowledge acquisition,

characteristic of successful student, knowledge construction and modification dimensions. Speed of knowledge acquisition and characteristic of successful student predicted selecting main ideas. The more students believed that learning is gradual and that success is related to hard work, the more likely they reported that they could identify main ideas. The more students believed that knowledge is actively acquired and can be modified, the more likely they reported using information processing study strategies.

In general, studies on the direct effect of epistemic beliefs on strategy uses show that students with sophisticated beliefs use a greater range of strategies and deeper strategies than students with naïve beliefs. This shows that epistemic beliefs may not only influence the range but also the depth of inquiry strategies students use.

The implications of this finding appear to be that IB Education students may hold epistemic beliefs that effect how they interpret their EE experience and how they participate in Education courses that emphasize an inquiry based approach to instruction. This does not appear to be the case when IB Education students are combined with Science students and compared to non-IB undergraduates. This finding may also have implications for the way the IB theory of knowledge course is taught since it may not directly confront students with the implications of the beliefs they hold for participation in different discipline-based undergraduate degrees leading to different professions.

INTRODUCTION: Research Question 6

Research question

Is there a significant difference between the learning approaches of pre-service teachers graduating from IB schooling compared to non-IB pre-service teachers?

Significant results

Instrument

The LPQ (Biggs, 1987a, 1987c) was used to measure approaches to learning. The LPQ has six scales, which measure Surface Motive, Surface Strategies, Deep Motive, Deep Strategies, Achieving Motive and Achieving Strategies, each with seven items.

Statistical analyses: 2X1 ANOVA, 2X6 MANOVA

Significant results: The LPQ ANOVA did not reveal a significant difference for total score. The LPQ MANOVA did not reveal a significant multivariate effect. Between-subject effects were significant for 1. Surface Motivation $F(1, 59) = 4.146$, $p = .046$, $\eta^2 = .066$) and 4. Deep Approach $F(1, 59) = 6.437$, $p = .014$, $\eta^2 = .098$).

LPQ mean differences

Surface Motivation $M = 15.46$ ($SD = .55$) < $M = 17.73$ ($SD = .97$)
Deep Approach $M = 20.78$ ($SD = .58$) < $M = 23.73$ ($SD = 1.01$)

LPQ MANOVA

Descriptive statistics

For the LPQ MANOVA, group 1 included 46 IB graduates and group 2 included 15 non-IB graduates.

The means and standard deviations for the IB and non-IB diploma as well as the totals for each factor are listed in Table 40. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Table 40
LPQ descriptive statistics

	Diploma Group	*Mean*	*Std. Deviation*	*N*
Surface Motive	IB	15.46	3.55	46
	Non-IB	17.73	4.37	15
	Total	16.02	3.86	61
Surface Approach	IB	16.48	4.09	46
	Non-IB	17.40	4.49	15
	Total	16.70	4.17	61
Deep Motive	IB	15.96	4.80	46
	Non-IB	16.40	4.49	15
	Total	16.07	4.69	61
Deep Approach	IB	20.78	3.94	46
	Non-IB	23.73	3.83	15
	Total	21.51	4.09	61
Achievement Motive	IB	17.07	3.67	46
	Non-IB	16.00	4.84	15
	Total	16.80	3.97	61
Achievement Approach	IB	19.87	4.53	46
	Non-IB	19.33	5.26	15
	Total	19.74	4.68	61

Test of assumptions

Box's Test of Equality of Covariance Matrices was significant ($M = 41.83$, $F(21, 2563) = 1.652$, $p < .031$), suggesting that the assumption of the homogeneity of variances-covariances has been violated. The Levene's tests did not report any significant difference, which suggests that equality of error variances can be safely assumed.

Multivariate test

The multivariate test did not reveal a significant difference. The MANOVA had moderate power .571.

Between-subject effects

The table of between-subject effects below shows that the factors 1-Surface Motivation ($F(1,59) = 4.146$, $p = .046$, partial $\eta^2 = .066$) and 4-Deep Approach ($F(1,59) = 6.437$, $p = .014$, partial $\eta^2 = .098$) present a significant difference between the two groups however all the effects are relatively small as can be noted in the Partial Eta Squared column. Furthermore, the estimate of power is weak across all the factors. The only exceptions being factors 1 and 4, which have the largest partial $\eta^2$and the most power at .517 and .704 respectively.

Group distributions

Figure 13. LPQ Factor #1 Surface Motivation group distributions

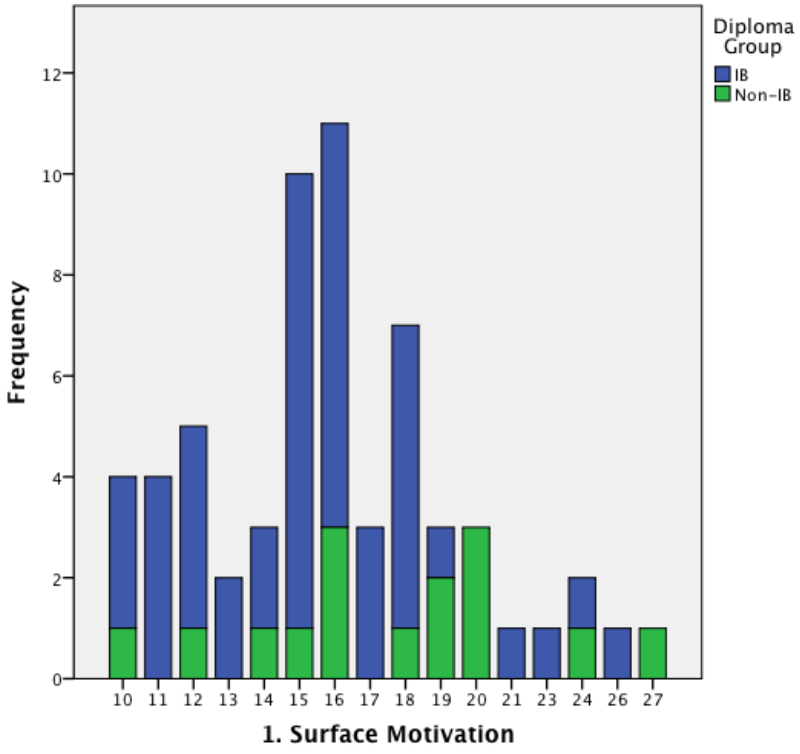
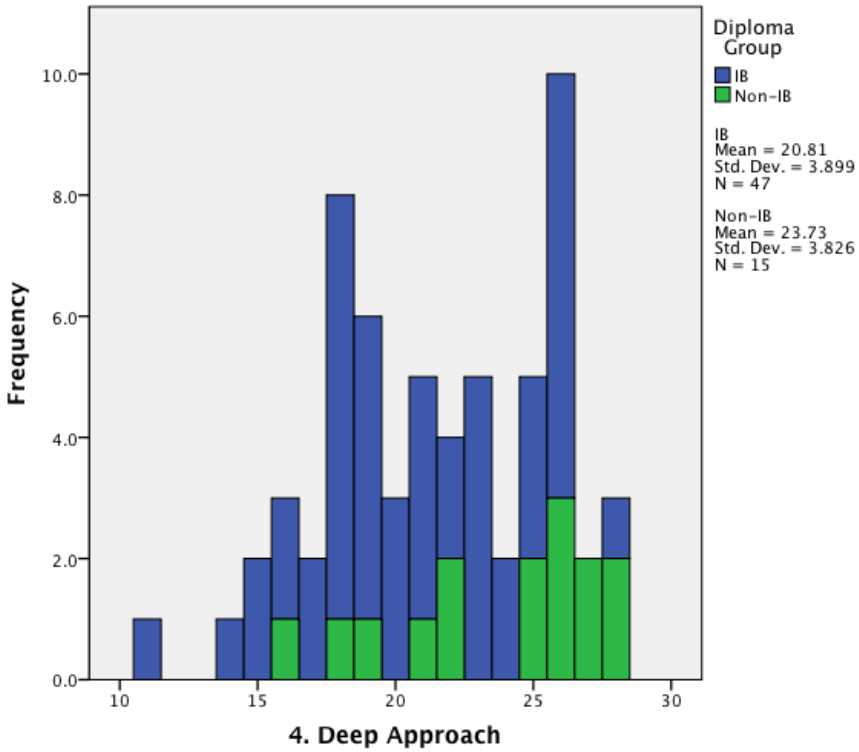


Figure 14. LPQ Factor #2 Deep Approach group distributions


Diploma Group
IB
Non-IB
IB
Mean = 20.81
Std. Dev. = 3.899
N = 47
Non-IB
Mean = 23.73
Std. Dev. = 3.826
N = 15
Frequency
0.0
2.0
4.0
6.0
8.0
10.0
10
15
20
25
30
4. Deep Approach

Discussion

The results of group comparisons show that the average Education IB student obtained a Surface Motive score of *M*=15.46 and the average Education non-IB student an *M* score=17.73 for Surface Motives. The lower IB score suggests that the typical non-IB student is likely to place a higher emphasis on surface motives for approaching learning in comparison to the IB student. This pattern remains true for the Deep Approach to learning with the IB *M*=20.78 and the non-IB *M*= 23.73. This pattern suggests that both the IB and non-IB students overall approach to learning is moderately higher for the deep approach to learning but there is a tension between the Surface motives and the Deep approach to learning.

Considerable efforts are being made in higher education to promote student centered rather than teacher and content centered learning (Commission, 1998). The IB Diploma Programme's extended essay requirement is in keeping with this movement. Yet this finding, as was the case for the belief results, suggests implications for the students' participation in their academic major as an undergraduate. Gijbels et al. (Gijbels, Segers, & Struyf, 2008) investigated the relationship between the initial approach to learning and the change in approaches to learning in a student centered learning environment and found that students' lack of change in terms of a deep learning approach was significantly and negatively influenced by their initial Deep approach when they entered a course. Accordingly, students' change in Surface learning approaches was significantly and negatively influenced by their initial Surface approach. So, the stronger the initial Deep or Surface approach of students, the less they change their approach. This also implies that the pattern above is what IB students are most likely to use as the initial expectation for the demands of college classes as a freshman.

Wilson and Fowler (2005) compared the Deep approaches to learning of Deep and Surface learners in a conventional teacher-centered course and an action learning-based course (project work, learning groups). Their results showed that deep learners remained relatively consistent in their Deep approach to learning across the two learning environments, indicating that these students were not influenced by the action-learning course. Surface learners, on the other hand, reported a significantly greater use of new deep learning strategies in the action-learning course, but there was no corresponding increase in their motives for Deep learning. These findings appear to be in contrast with the finding that students with a preference for Deep approaches were more likely to recognize the learning potential of constructivist teaching strategies than were students with dominantly Surface learning preferences, who tended to focus on the transmission aspects of teaching and the reproductive aspects of learning (Cambell et al., 2001).

The IB and non-IB students in this study represent a pattern of moderate Surface motive scores and high Deep approach scores. However, the Surface motive is significantly lower for the IB students in combination with a Deep approach to

learning scores that are not that much different from non-IB students if transformed to a decile score. Leung, Mok & Wong (2008) reported that in a course without a specific form of intervention using student-centered teaching methods, those who obtained a low Surface score and high Deep score approach to learning, similar to the IB students in this study, did not make a significant deep learning change during the course. Thus, if it is assumed that past research findings have relevance to the current findings, there is reason to wonder if *approach to learning* is likely to account for the importance students assign to inquiry who have been a participant in IB schooling for several years and graduated with an IB Diploma. Research Question 7 should offer further insights into this question.

INTRODUCTION: Research Question 7

Research question

Is there a significant difference between the value assigned to inquiry instruction of pre-service teachers graduating from IB schooling compared to non-IB pre-service teachers?

Significant results

Instrument

The MSDIQ is a 79-item questionnaire (Shore, et al., 2012; Syer, 2007) with an 11-point Likert scale and 3 subscales: Preparation for an Inquiry Project, 29 items, Enactment of the Inquiry Project, 43 items, Reflection on the Enactment, 5 items. Briefly, exploratory factor analysis results demonstrated that the MSDIQ has 13 factors which can be organized into three dimensions: 1) basic entry level inquiry strategies, 2) the enactment of social and cognitive strategies that must be primarily self-regulated by the student, and 3) inquiry reflective strategies that enable students to improve their ability to deliberately self-regulate the process of inquiry alone.

Statistical analyses: 2X1 ANOVA, 2X12 MANOVA

Significant results: Two significant results were obtained for the MSDIQ, factor Preparation 6 ($F(1, 91) = 4.293$, $p = .013$, $\eta^2 = .066$) and Reflection 1 ($F(1, 91) = 6.045$, $p = .006$, $\eta^2 = .080$).

MSDIQ mean differences

Preparation 6 $M = .30$ ($SD = .12$) > $M = –.37$ ($SD = .23$)
Reflection 1 $M = .12$ ($SD = .15$) > $M = –.32$ ($SD = .28$)

RESULTS

MSDIQ MANOVA

Descriptive statistics

For the MSDIQ MANOVA, group 1 included 40 IB graduates and group 2 included 11 non-IB graduates.

The means and standard deviations for the IB and non-IB diploma as well as the totals for each factor are listed in Table 41. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Table 41
MSDIQ descriptive statistics

	Diploma Group	*Mean*	*Std. Deviation*	*N*
1. Inquiry Comprehension	IB	8.60	1.53	39
	Non-IB	8.25	1.15	11
	Total	8.52	1.45	50
2. Generative Inquiry	IB	8.51	1.47	39
	Non-IB	7.86	1.02	11
	Total	8.37	1.40	50
3. Inquiry Planning	IB	7.38	1.72	39
	Non-IB	6.71	2.54	11
	Total	7.23	1.92	50
4. Problem Solving	IB	7.02	2.05	39
	Non-IB	6.36	1.95	11
	Total	6.88	2.03	50
5. Inquiry Teaching	IB	7.60	1.78	39
	Non-IB	6.78	1.65	11
	Total	7.42	1.77	50
6. Co-Construction of Inquiry	IB	7.55	1.81	39
	Non-IB	5.98	2.39	11
	Total	7.20	2.03	50
7. Student Data Organization Strategies	IB	7.31	1.92	39
	Non-IB	7.10	1.93	11
	Total	7.27	1.91	50
8. Student Inquiry Communication Strategies	IB	7.62	1.58	39
	Non-IB	7.11	1.77	11
	Total	7.51	1.62	50
9. Student Formal	IB	8.18	1.55	39
	Non-IB	7.62	1.61	11

Reasoning Strategies	Total	8.06	1.56	50
10. Student Data Interpretation Strategies	IB	7.85	1.88	39
	Non-IB	7.91	1.46	11
	Total	7.86	1.79	50
11. Student Self-Regulation Strategies for Inquiry Engagement	IB	7.76	1.90	39
	Non-IB	7.57	1.99	11
	Total	7.72	1.90	50
12. Student Search Strategies	IB	7.85	1.99	39
	Non-IB	7.71	2.18	11
	Total	7.82	2.01	50
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	IB	7.98	1.89	39
	Non-IB	7.19	1.44	11
	Total	7.81	1.82	50

Test of assumptions

Box's Test of Equality of Covariance Matrices was not calculated because the determinant of the covariance matrix was singular suggesting that the assumption of the homogeneity of variances-covariances has been violated.

The assumption of equality of variances was verified by the Levene's Test.

Multivariate test

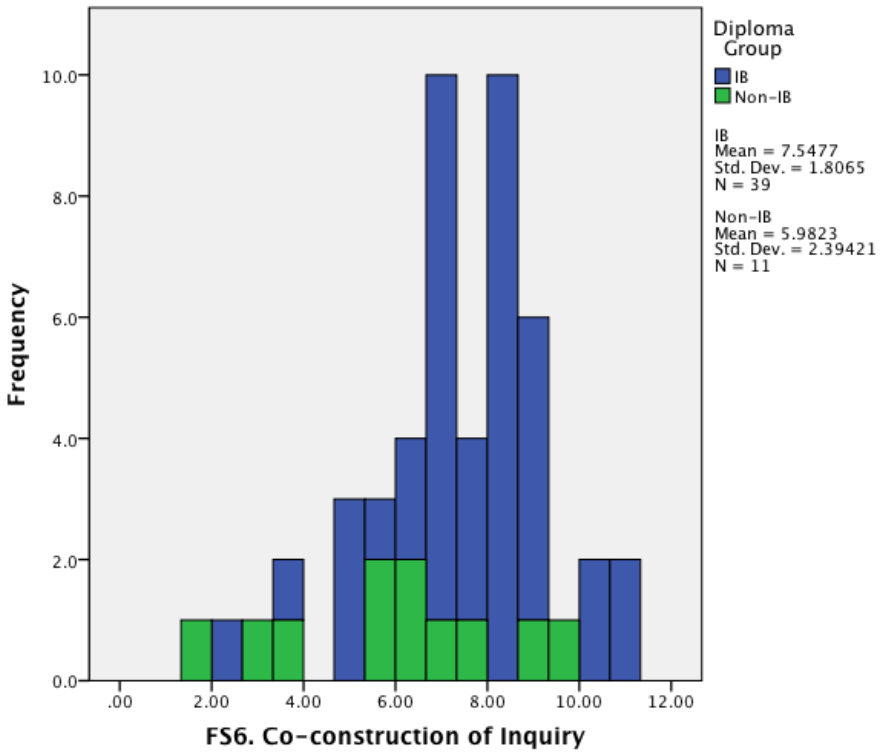
The multivariate test did not reveal a significant difference between groups ($\Lambda = .714$, $F(14, 36) = 1.030$, $p < .447$, partial $\eta^2 = .286$). The MANOVA had moderate power .512.

Between-subject effects

The table of between-subject effects below shows that none of the factors except 6. Co-construction of inquiry ($F(1,49) = 6.736$, $p = .012$, partial $\eta^2 = .121$) present a significant difference between the two groups however all the effects are relatively small as can be noted in the Partial Eta Squared column. Further, powers are weak across all the factors. The only exception being factor 6, which has the largest partial $\eta^2$and the most power at .72.

Group distributions

Figure 15. MSDIQ Factor #FS6 Co-Construction of Inquiry



DISCUSSION

Do pre-service teachers who have earned an IB Diploma differ in their designation of importance to the academic demands of inquiry instruction and learning from those pre-service teachers who came from non-IB secondary training?

The overall results of comparing IB and non-IB pre-service teacher ratings of the MSDIQ demands of inquiry instruction and learning indicate significant differences between groups in their ratings of the importance of *teacher and student collaboration or co-construction of inquiry*. There is some recent IB research that appears to have been done on this issue (See Coca et al, 2012).

The other inquiry demand that undergraduate pre-service teachers perceived to be more important than the non-IB student was the Reflection dimensions of inquiry instruction and learning. This dimension of instruction also distinguished IB and non-IB graduates who were majoring in Education or Science. Therefore the combined results from Research Question one and this research question offers cross-disciplinary evidence that Reflection is also perceived by Education IB students to be a very important dimension of inquiry e.g. 8.0 on a 10.0 scale.

Influencing students' approaches towards Deep learning by means of implementing student-centered learning environments is a complex process. The specific planning dimension that distinguished between IB and non-IB students was the significantly more positive rating given to *Teacher and student co-construction of inquiry learning*. The comparison of IB Science and Education students to non-IB students did not result in a significant difference in this item or in any other of the Entry Level Inquiry Demands. Instead significant differences were found in the *communication strategies* necessary to the enactment of inquiry during the EE. This research finding is important but it is only associated with the IB graduates who major in Education. This is interpreted to be important because the rating given to the importance of *the teacher and student co-construction of inquiry* learning item was the highest rating given by the Education student in this study of all the items on the MSDIQ. As this finding is explored in light of the current research literature a number of interpretations of what students mean by that rating will be speculated. These IB graduates will most influence what happens in classrooms in the next generation including IB schools where these students may be hired. Equally important: in the next phase interview questions can be designed that offer qualitative data on this issue.

Garrison and Cleveland (2004) reported that the amount of involvement and presence of the teacher seems to matter to students' approaches to learning in four college courses that differed in the amount of teacher involvement in online conferencing, and they also concluded that teacher involvement contributed to the adoption of deep approaches to learning. This analysis of the EE as a curriculum process (not only as a set of curriculum policies that govern the broad structure, goals and resources given to the EE) is guided by Doyle's (1992) conclusion from a

review of a decade of research on curriculum that what most shapes the curriculum as a process in classrooms is the interaction between the teacher and students. Throughout the EE, the supervisor, through a series of meetings and feedback on students plans and actions as an inquirer, shapes what students learn about how to inquire and how to self-regulate the process of inquiry regardless of whether it's a series of science experiments, observations and interpretations initiated by a social problem or an investigation using an historical method or a project framed by an issue and an argument.

It may be that when Education IB graduates emphasize the importance of teacher and student co-construction of inquiry, they are recognizing the fragile and difficult enterprise of collaborating with the supervisor during a complex and challenging process. Moreover, the data suggests that IB Education students hold naïve epistemic beliefs that may cause them to resist, or misconceive the goal of promoting understanding through inquiry. Instead they may use the EE to compile information or go through the procedures set out in a lab manual to guide their path in constructing an EE product. In addition, considerable research, reviewed in the discussion of research question 5, demonstrates that beliefs do affect the strategies one uses to accomplish learning outcomes. Equally important: the kind of approach to learning one brings to the process and demands of inquiry underlying the EE also may create misconceptions about what is to be accomplished as evidence of learning. This claim has been supported by the literature reviewed as part of the discussion of question 6. However, the major point here is that a lack of alignment exists between the students epistemic beliefs and/or approach to learning, which may not itself be aligned with the EE goals of inquiry learning or learning how to inquire through the EE experience.

The nature of the EE as a process places considerable cognitive and social demands on the typical student especially in light of the Education students' more naïve epistemic beliefs. Second, the provision for a supervisor for each student enrolled in the EE is a likely reason why the Education students rate teacher and student co-construction of inquiry so high in importance. However, there are many different ways in which the roles of the teacher and student inquirer might play out over several years of meetings. And each way might represent a different reason for the student to rate the teacher and student co-construction of the EE experience. Moreover, they may lead to different contexts for coping with beliefs about knowledge and knowing and the internalization of how to inquire.

The EE can be interpreted by the teacher to be an independent study carried out by the student as a means to teach content where the student can choose a topic or issue of personal interest and learn more about it for the purpose of understanding it more deeply (a Deep motive). In this situation the student rather than the teacher takes the primary responsibility for what is learned and the teacher may play the role of an evaluator, a coach or a facilitator. It may be interpreted by the teacher as an opportunity for students to learn how to read critically as a scholar or researcher. In this case the teacher may attempt to also teach knowledge of how to

make sense of the research literature in a particular domain such as science or history. The teacher may interpret the EE as a way to simultaneously teach students the systems and the strategies of inquiry as well as stimulate students to learn more about the content of the inquiry. In this situation students learn how to do experiments, research and investigations as they do them. Co-construction of learning is necessary and sufficient to promote knowledge of how to do inquiry and of how to address questions systematically through a methodology. Co-construction occurs as a scaffold for learning (Bell, Urhahne, Schanze, & Ploetzner, 2009). Indeed Sproken-Smith & Walker (2010) argue that inquiry-based instruction cannot happen without scaffolding student learning. The teacher may interpret the EE as a means of guiding students to use the knowledge taught in other courses in the DP curriculum and to apply it during the EE and evaluate students according to a public set of standards relevant to the a quality product. The teacher's role is to primarily explain the standards and evaluate what students produce using them. All of these alternatives place different emphases on how the students and the teacher will proceed in enacting the extended essay. But as Doyle (1992) has argued in his review of the explicit, hidden and constructed curriculum, the explicit policies and resources aspect of the curriculum does not fully control the teacher and the students co-construction of learning.

The allocation of time to the EE throughout the Diploma Programme does make evident that its value to the IB curriculum is in line with its consistent emphasis on becoming an *inquiring person*. Still, given that the traditional schooling system in North America and Europe is based more on structuring learning to meet admissions criteria for the next education level, the intended IB goals of promoting inquirers and providing an opportunity for learning how to learn and how to inquire could give the impression to students and parents that the EE is not well aligned with the standards for university admissions. Indeed this very concern was at the heart of the Boyer Commission and its urging that the best universities provide more rather than less opportunity for undergraduates to be engaged in courses that require them to be being more active in the process of inquiry (Commission, 1998)

The Reflection Factor

The second dimension of inquiry instruction and learning where Education IB and non-IB undergraduates were significantly different was on items contributing to the Reflection Factor on the MSDIQ. The ratings on items describing metacognitive processes of reflecting, evaluating and self-questioning were found to distinguish the IB from the non-IB undergraduate ratings. The correlation of each item to the total score on the Reflection factor is high: 1) reflect on the meaningfulness of the inquiry experience (rp.8, $p = .001$), 2); evaluate the inquiry experience (rp .746, $p = .001$); and 3) question the findings (rp .673, $p = .001$).

What is especially interesting about the significant difference between IB and non-IB student ratings of the importance of Reflection is that it is a sophisticated level of

appreciation of the inquiry process as a continuous ongoing process where one investigation and its results should put the investigator in a position to predict implications for the next one. The review of the literature by Bell et al. (2009) of 14 separate articles written about inquiry structure and learning, found that all 14 authors of these articles tended to agree on the main inquiry processes. Prediction is one common factor that occurs in all 14 research articles.

INTRODUCTION: Research Question 8

Research question

Is there a significant difference between the inquiry self-efficacy of pre-service teachers graduating from DP IB schooling compared to each other and to non-IB pre-service teachers?

Significant results

Instrument: The SDEIQ is a 69-item instrument (Aulls & Shore, 2010) designed to estimate students' confidence in accomplishing inquiry tasks and situations arising when inquiry is engaged in any setting and in formal education settings.

Statistical analyses: 2X1 ANOVA, 2X7 MANOVA

Significant results: An ANOVA was run for the two groups on the total score for the SDEIQ. A Subsequent MANOVA was run on the factor scores for the instrument. No significant results were obtained for the SDEIQ.

Summary

The comparison of the Education IB and non-IB students indicates no significant differences in self-efficacy or student views of nature of science. Significant differences did occur on epistemic beliefs, approach to learning and the ratings of important demands of inquiry instruction and learning. While IB student ratings of the teacher and student co-construction of learning and the student reflection were significantly higher than the non-IB students, their epistemic beliefs, especially about simple knowledge and approach to learning, were significantly different. The implications for IB teachers and university faculty in courses that emphasize student centered learning may be that the IB students hold beliefs that conflict with learning strategies for how to inquire and to teach inquiry. Moreover, the IB Education students' approach to the learner profile is also at odds with the goals of inquiry based instruction, which emphasize understanding and higher order thinking outcomes.

On the other hand, when Education and Science IB students are combined and then compared to non-IB schooled undergraduates, they are significantly different than non-IB students. This suggests that the EE may be offering opportunities for students with more interest in Science. The actual qualitative differences in perceptions of Education majors and Science majors in this regard will be included in the Phase II qualitative case study.

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Appendix A

Description of instruments

McGill Demands of Inquiry Questionnaire (Bruce M. Shore, et al., 2012; Syer, 2007): A 79-item questionnaire with an 11-point Likert scale and 3 subscales: Preparation for an Inquiry Project, 29 items (.93), Enactment of the Inquiry Project, 43 items (.96), Reflection on the Enactment, 5 items (.90). The subscales are considered dimensions of the demands of inquiry. Whole-test score reliability is .97. Factor validity was confirmed for each subscale with exploratory and confirmatory factor analyses; construct validity supported the total score. Fourteen factors were identified in the confirmatory factor analysis by Shore et al (2012), with six being organized under the planning subscale, six organized under the enactment subscale, and two organized under the reflection subscale. Because the meaning of the scores on survey instruments are especially sensitive to the nature of the population on which they are normed, a different exploratory factor analysis was carried out using the undergraduate students who could be identified from a sample of 300 as obtaining an International Baccalaureate Diploma before enrolling as undergraduates and a second sample of students who received some other secondary preparation but were accepted into the faculty of Sciences or the faculty of Education. The results of this analysis confirmed 13 of the 14 factors identified in the previous studies. However, it suggests different factor groupings for maximal interpretation in this study. The appendices provide the statistical results of the Exploratory Factor Analysis and a description of the factors. Additionally, the organization of the groupings into three dimensions is included. Briefly, exploratory factor analysis results demonstrated that the MSDIQ has 13 factors which can be organized into three dimensions: 1) basic entry level inquiry strategies, 2) the enactment of social and cognitive strategies that must be primarily self-regulated by the student, and 3) inquiry reflective strategies that enable students to improve their ability to deliberately self-regulate the process of inquiry alone.

The Inquiry Self-Efficacy Survey: SDEIQ (M. W. Aulls & Shore, 2010). This 69-item instrument is designed to estimate students' confidence in accomplishing inquiry tasks and situations arising when inquiry is engaged in any setting and in formal education settings. It is divided into seven subscales: Interpretation and Presentation of Results (15 items), Domain General Strategies, (12 items), Data Analysis (11 items), Self-regulatory Strategies (10 items), Classroom Cooperation Behaviors During Inquiry Instruction (7 items), Inquiry Disposition (3 items), and Inquiry Small Group Collaboration Behaviors (10 items). An exploratory factor analysis confirms the independence of each subscale and the factorial validity of the measure. Chronbach Alpha is .901 for the total score and .938, .915, .903, .880, .837, .663 and .909 for each of the scales in the order given above.

Schommer-Aikins Epistemic Beliefs Questionnaire: SEBQ (Schommer, 1990; M. Schommer-Aikins, et al., 2003). This 63-item questionnaire has a 5-point Likert

scale from 1 (strongly disagree) to 5 (strongly agree). Lower scores represent sophisticated beliefs and higher scores naïve beliefs about knowledge. There are 5 knowledge dimensions: certain knowledge, simple knowledge, quick learning, innate ability, and omniscient authority. Confirmatory factor analyses by multiple investigators support 4 of the original 5 factors. Reliability ranges between .70 and .89.

The Biggs Learning Process Questionnaire: LPQ (John B. Biggs, 1987a, 1987c). This is a 36-item questionnaire designed to measure approaches to learning. The LPQ has six scales, which measure Surface Motive, Surface Strategies, Deep Motive, Deep Strategies, Achieving Motive and Achieving Strategies, each with seven items. However, the motive and strategies within the surface, deep and achieving dimensions of study behavior can be combined to form approaches to study, each with 12 items. The LPQ has been extensively used in studies investigating learning behaviors in tertiary education (J. Biggs, 1996, 1999; J. Biggs, et al., 2001; John B. Biggs, 1987a, 1987b, 1987c; J. B. Biggs, 1988; Watkins & Murphy, 1994).

Views of Nature of Science Questionnaire: VNOS-C. (Lederman, et al., 2002) consists of 10 open-ended questions designed to probe views of specific aspects of the scientific enterprise. It is validated for use with the intended participants.

The open-ended nature of the VNOS-C allows respondents to use their own words and examples, without being forced into a choice. Total Score $\alpha = .73$.

Appendix B

MsDIQ Exploratory Factory Analysis

Syntax

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1) Basic entry-level inquiry strategies

	1. Inquiry Comprehension	2. Generative Inquiry	3. Inquiry Planning	4. Problem Solving	5. Inquiry Teaching	6. Co-Construction of Inquiry
1- for the student and teacher to have co-ownership of the question	-0.11	0.035	0.005	0.026	0.453	0.384
2- for the student and teacher to share construction of the curriculum	0.023	-0.02	0.132	0.01	0.038	0.544

3- for the student and teacher to share decision-making	0.092	0.016	-0.002	-0.053	0.048	0.778
4- for the student to extend inquiry beyond the classroom	0.311	0.059	-0.013	0.171	0.148	-0.137
5- for the teacher to tap into the student's and his or her own interests	0.084	0.267	-0.184	0.025	-0.141	0.103
6- for the teacher to address his or her needs and student's needs	0.296	-0.014	0.218	-0.131	0.247	0.062
7- for the teacher to provide a mentor	-0.037	-0.209	0.086	0.055	0.724	0.119
8- for the teacher to model skills needed for the inquiry	0.07	-0.078	-0.145	0.218	0.673	-0.031
9- for the teacher to give the amount of time needed, be flexible with time	0.022	0.243	-0.048	-0.302	0.648	0.009
10- for the student to	0.431	0.117	0.199	-0.109	0.186	-0.149

organize time and space						
11- for the student to understand the goal of the task	0.859	-0.115	-0.038	-0.152	-0.132	0.125
12- for the student to divide the task into a coherent sequence of do-able steps	0.41	-0.177	0.081	0.358	-0.014	-0.079
13- for the student to make a concept map or web or cluster	-0.214	0	0.155	0.645	0.057	-0.084
14- for the student to foresee possible outcomes of the activity	0.269	0.049	0.132	0.443	-0.105	0.045
15- for the student to understand key concepts	0.609	-0.19	-0.128	0.322	0.073	0.009
16- for the student to understand instructions	0.695	0.108	0.025	-0.111	-0.029	0.082
17- for the student to describe his or her own problem-solving strategies	0.1	0.093	0.189	0.618	-0.175	0.11

18- for the teacher to encourage honest criticism of ideas	0.222	0.392	-0.149	0.315	0.186	0.019
19- for the teacher to encourage creative risk-taking	-0.002	0.563	-0.06	0.145	0.068	0.049
20- for the student to connect old and new knowledge	0.531	0.335	-0.064	0.033	-0.015	-0.025
21- for the student to set aside preparation time	0.4	0.079	0.392	-0.043	0.08	-0.112
22- for the student to make a plan	0.136	-0.065	0.599	0.116	0.007	-0.028
23- for the student to have different plans in advance to accomplish the task	-0.149	-0.006	0.787	0.302	-0.084	0.04
24- for the student to have back up plans at the end should the project stall	0.067	0.086	0.769	0.045	0.001	0.089
25- for the student to feel free to use imagination	-0.015	0.782	0.122	-0.114	-0.141	-0.035

26- for the student to restate or reformat the problem	-0.01	0.225	0.057	0.517	-0.014	-0.05
27- for the student to make suggestions	-0.057	0.597	-0.024	0.312	-0.042	0.029
28- for the student to share emotions, feelings, ideas, and opinions	-0.233	0.323	0.174	0.131	0.231	-0.016
29- for the student to develop expectations of what will happen next	-0.06	0.078	0.042	0.425	0.094	0.039

2) The enactment of social and cognitive strategies that must be primarily self-regulated by the student

	7. Student Data Organization Strategies	8. Student Inquiry Communication Strategies	9. Student Formal Reasoning Inquiry Strategies	10. Student Data Interpretation Strategies	11. Student Self-Regulation Strategies for Inquiry Engagement	12. Student Search Strategies
30- for the student to offer hypotheses about outcomes	0.159	0.071	-0.011	0.555	0.04	-0.062
31- for the student to make careful	0.296	0.123	-0.109	0.602	-0.053	0.068

observations						
32- for the student to identify where to obtain data	0.271	-0.169	0.261	0.419	-0.048	0.032
33- for the student to recognize hidden meanings in data	0.155	-0.137	0.25	0.527	-0.135	0.152
34- for the student to record data	0.734	-0.179	0.068	0.141	-0.034	0.125
35- for the student to classify data	0.601	-0.084	-0.011	0.197	0.102	0.072
36- for the student to search for resources beyond textbooks	0.122	0.013	-0.123	0.292	-0.009	0.568
37- for the student to search the Internet and World Wide Web	0.098	0.12	-0.211	-0.124	0.084	0.729
38- for the student to separate relevant and irrelevant information	0.032	0.092	0.064	0.028	-0.110	0.667
39- for the student to apply previous knowledge to new	-0.033	0.275	0.019	0.374	0.009	0.154

concepts						
40- for the student to understand how preconceptions affect learning	-0.009	0.175	-0.051	0.571	0.244	-0.217
41- for the student to be aware of how the inquiry event affects him or her personally	0.018	0.091	-0.049	0.329	0.557	-0.271
42- for the student to keep an open mind to change	-0.217	-0.012	0.086	0.223	0.503	0.284
43- for the student to address doubts directly	-0.017	-0.096	-0.041	-0.032	0.819	0.144
44- for the student to assist others to make observations	0.292	0.111	-0.264	-0.025	0.683	0.021
45- for the student to find patterns in data	0.428	-0.095	0.285	0.122	0.212	-0.082
46- for the student to value personal judgment	-0.003	0.169	0.217	-0.057	0.535	-0.109

47- for the student to verify data or information	0.302	-0.107	0.517	-0.175	0.203	0.141
48- for the student to compare and contrast data with someone else 's	0.288	0.137	0.382	-0.143	0.193	-0.143
49- for the student to anticipate and respond to arguments in opposition to one's view	-0.097	-0.004	0.621	0.063	0.152	0.023
50- for the student to seek different viewpoints	-0.188	-0.075	0.266	0.379	0.282	0.189
51- for the student to test ideas and hypotheses	0.013	0.229	0.403	0.264	-0.047	-0.035
52- for the student to construct new knowledge	-0.163	0.501	0.317	-0.001	0.02	0.125
53- for the student to interact with or manipulate his or her surroundin	0.007	0.429	0.136	-0.024	0.208	0.067

gs						
54- for the student to communicate one's learning with others	-0.077	0.683	0.081	0.17	-0.11	0.101
55- for the student to consider diverse means of communication	0.046	0.651	-0.009	0.039	0.102	-0.052
56- for the student to organize the presentation of the project	0.144	0.544	0.017	-0.057	0.066	0.201
57- for the student to present data in tables and graphs	0.61	0.328	-0.148	0.029	-0.097	0.082
58- for the student to use vocabulary appropriate to the audience and topic	0.317	0.181	0.321	-0.16	-0.013	0.27
59- for the student to accept that more than one solution might be appropriate	0.118	0.065	0.838	0.058	-0.138	-0.15

60- for the student to apply new knowledge to future experiences	-0.015	0.232	0.803	0.072	-0.168	-0.128
61- for the student to record methods, results, and conclusions	0.612	0.067	0.093	0.144	0.043	-0.066

3) Inquiry reflective strategies that enable students to improve their ability to deliberately self-regulate the process of inquiry alone.

	13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences
62- for the student to explain the results	0.563
63- for the student to question the findings	0.673
64- for the student to reflect upon his or her inquiry experience	0.800
65- for the student to discuss what has been learned compared to what was known before	0.677
66- for the student to evaluate the inquiry experience	0.746
67- for the student to follow-up the project with a new set of questions	0.561

Appendix C

Syntax

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Appendix D

SDEIQ Bivariate Correlations

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SDEIQ_Factor_01	Pearson Correlation	1	.707**	.779**	.721**	.682**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	245	237	239	243	239
SDEIQ_Factor_02	Pearson Correlation	.707**	1	.676**	.641**	.573**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	237	246	239	244	237
SDEIQ_Factor_03	Pearson Correlation	.779**	.676**	1	.739**	.597**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	239	239	247	245	237
SDEIQ_Factor_04	Pearson Correlation	.721**	.641**	.739**	1	.583**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	243	244	245	254	242
SDEIQ_Factor_05	Pearson Correlation	.682**	.573**	.597**	.583**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	239	237	237	242	243
SDEIQ_Factor_06	Pearson Correlation	.549**	.457**	.556**	.497**	.514**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	244	244	246	252	242
SDEIQ_Factor_07	Pearson Correlation	.780**	.733**	.723**	.685**	.742**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	242	243	245	250	240
SDEI_total	Pearson Correlation	.915**	.848**	.881**	.835**	.795**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	223	223	223	223	223

		SDEIQ_Factor_06	*SDEIQ_Factor_07*	*SDEI_total*
SDEIQ_Factor_01	Pearson Correlation	.549	.780**	.915**
	Sig. (2-tailed)	.000	.000	.000
	N	244	242	223

SDEIQ_Factor_02	Pearson Correlation	.457**	.733	.848**
	Sig. (2-tailed)	.000	.000	.000
	N	244	243	223
SDEIQ_Factor_03	Pearson Correlation	.556**	.723**	.881
	Sig. (2-tailed)	.000	.000	.000
	N	246	245	223
SDEIQ_Factor_04	Pearson Correlation	.497**	.685**	.835**
	Sig. (2-tailed)	.000	.000	.000
	N	252	250	223
SDEIQ_Factor_05	Pearson Correlation	.514**	.742**	.795**
	Sig. (2-tailed)	.000	.000	.000
	N	242	240	223
SDEIQ_Factor_06	Pearson Correlation	1**	.562**	.650**
	Sig. (2-tailed)		.000	.000
	N	254	251	223
SDEIQ_Factor_07	Pearson Correlation	.562**	1**	.905**
	Sig. (2-tailed)	.000		.000
	N	251	254	223
SDEI_total	Pearson Correlation	.650**	.905**	1**
	Sig. (2-tailed)	.000	.000	
	N	223	223	223

**. Correlation is significant at the 0.01 level (2-tailed).

MsDIQ Bivariate Correlations

		MsDIQ_FS1	*MsDIQ_FS2*	*MsDIQ_FS3*	*MsDIQ_FS4*	*MsDIQ_FS5*
MsDIQ_FS1	Pearson Correlation	1	.402**	.491**	.620**	.481**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	94	94	94	94	94
MsDIQ_FS2	Pearson Correlation	.402**	1	.384**	.607**	.457**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	94	94	94	94	94
MsDIQ_FS3	Pearson Correlation	.491**	.384**	1	.669**	.449**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	94	94	94	94	94
MsDIQ_FS4	Pearson Correlation	.620**	.607**	.669**	1	.495**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	94	94	94	94	94
MsDIQ_FS5	Pearson Correlation	.481**	.457**	.449**	.495**	1

	Sig. (2-tailed)	.000	.000	.000	.000	
	N	94	94	94	94	94
MsDIQ_FS6	Pearson Correlation	.144	.328**	.359**	.300**	.470**
	Sig. (2-tailed)	.166	.001	.000	.003	.000
	N	94	94	94	94	94
MsDIQ_FSDS1	Pearson Correlation	.637**	.361**	.467**	.495**	.354**
	Sig. (2-tailed)	.000	.000	.000	.000	.001
	N	92	92	92	92	92
MsDIQ_FSDS2	Pearson Correlation	.661**	.553**	.574**	.637**	.511**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	92	92	92	92	92
MsDIQ_FSDS3	Pearson Correlation	.723**	.476**	.401**	.485**	.484**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	92	92	92	92	92
MsDIQ_FSDS4	Pearson Correlation	.699**	.490**	.454**	.691**	.450**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	92	92	92	92	92
MsDIQ_FSDS5	Pearson Correlation	.411**	.683**	.452**	.562**	.521**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	92	92	92	92	92
MsDIQ_FSDS6	Pearson Correlation	.526**	.336**	.264*	.368**	.292**
	Sig. (2-tailed)	.000	.001	.011	.000	.005
	N	92	92	92	92	92
MsDIQ_FSDSR1	Pearson Correlation	.595**	.599**	.548**	.654**	.589**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	94	94	94	94	94

		MsDIQ_FS6	*MsDIQ_FSDS1*	*MsDIQ_FSDS2*	*MsDIQ_FSDS3*	*MsDIQ_FSDS4*
MsDIQ_FS1	Pearson Correlation	.144	.637**	.661**	.723**	.699**
	Sig. (2-tailed)	.166	.000	.000	.000	.000
	N	94	92	92	92	92
MsDIQ_FS2	Pearson Correlation	.328**	.361	.553**	.476**	.490**
	Sig. (2-tailed)	.001	.000	.000	.000	.000
	N	94	92	92	92	92

MsDIQ_FS3	Pearson Correlation	.359**	.467**	.574	.401**	.454**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	94	92	92	92	92
MsDIQ_FS4	Pearson Correlation	.300**	.495**	.637**	.485	.691**
	Sig. (2-tailed)	.003	.000	.000	.000	.000
	N	94	92	92	92	92
MsDIQ_FS5	Pearson Correlation	.470**	.354**	.511**	.484**	.450
	Sig. (2-tailed)	.000	.001	.000	.000	.000
	N	94	92	92	92	92
MsDIQ_FS6	Pearson Correlation	1	.057**	.245**	.195**	.173**
	Sig. (2-tailed)		.592	.019	.062	.099
	N	94	92	92	92	92
MsDIQ_FSDS1	Pearson Correlation	.057**	1**	.640**	.659**	.701**
	Sig. (2-tailed)	.592		.000	.000	.000
	N	92	92	92	92	92
MsDIQ_FSDS2	Pearson Correlation	.245**	.640**	1**	.695**	.623**
	Sig. (2-tailed)	.019	.000		.000	.000
	N	92	92	92	92	92
MsDIQ_FSDS3	Pearson Correlation	.195**	.659**	.695**	1**	.723**
	Sig. (2-tailed)	.062	.000	.000		.000
	N	92	92	92	92	92
MsDIQ_FSDS4	Pearson Correlation	.173**	.701**	.623**	.723**	1**
	Sig. (2-tailed)	.099	.000	.000	.000	
	N	92	92	92	92	92
MsDIQ_FSDS5	Pearson Correlation	.302**	.447**	.576**	.552**	.525**
	Sig. (2-tailed)	.003	.000	.000	.000	.000
	N	92	92	92	92	92
MsDIQ_FSDS6	Pearson Correlation	.011**	.604**	.645*	.529**	.535**
	Sig. (2-tailed)	.918	.000	.000	.000	.000
	N	92	92	92	92	92
MsDIQ_FSDSR1	Pearson Correlation	.386**	.506**	.605**	.614**	.667**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	94	92	92	92	92

		MsDIQ_FSDS5	*MsDIQ_FSDS6*	*MsDIQ_FSDSR1*
MsDIQ_FS1	Pearson Correlation	.411	.526**	.595**
	Sig. (2-tailed)	.000	.000	.000
	N	92	92	94
MsDIQ_FS2	Pearson Correlation	.683**	.336	.599**
	Sig. (2-tailed)	.000	.001	.000
	N	92	92	94
MsDIQ_FS3	Pearson Correlation	.452**	.264**	.548
	Sig. (2-tailed)	.000	.011	.000
	N	92	92	94
MsDIQ_FS4	Pearson Correlation	.562**	.368**	.654**
	Sig. (2-tailed)	.000	.000	.000
	N	92	92	94
MsDIQ_FS5	Pearson Correlation	.521**	.292**	.589**
	Sig. (2-tailed)	.000	.005	.000
	N	92	92	94
MsDIQ_FS6	Pearson Correlation	.302	.011**	.386**
	Sig. (2-tailed)	.003	.918	.000
	N	92	92	94
MsDIQ_FSDS1	Pearson Correlation	.447**	.604**	.506**
	Sig. (2-tailed)	.000	.000	.000
	N	92	92	92
MsDIQ_FSDS2	Pearson Correlation	.576**	.645**	.605**
	Sig. (2-tailed)	.000	.000	.000
	N	92	92	92
MsDIQ_FSDS3	Pearson Correlation	.552**	.529**	.614**
	Sig. (2-tailed)	.000	.000	.000
	N	92	92	92
MsDIQ_FSDS4	Pearson Correlation	.525**	.535**	.667**
	Sig. (2-tailed)	.000	.000	.000
	N	92	92	92
MsDIQ_FSDS5	Pearson Correlation	1**	.287**	.620**
	Sig. (2-tailed)		.006	.000
	N	92	92	92
MsDIQ_FSDS6	Pearson Correlation	.287**	1**	.281*
	Sig. (2-tailed)	.006		.007
	N	92	92	92
MsDIQ_FSDSR1	Pearson Correlation	.620**	.281**	1**
	Sig. (2-tailed)	.000	.007	
	N	92	92	94

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

SEBQ Bivariate Correlations

		1. Seek Single Answers	2. Avoid Integration *n*	3. Avoid Ambiguity	4. Knowledge is Certain
1. Seek Single Answers	Pearson Correlation	1	.470**	.469**	.385**
	Sig. (2-tailed)		.000	.000	.000
	N	125	124	125	124
2. Avoid Integration	Pearson Correlation	.470**	1	.411**	.306**
	Sig. (2-tailed)	.000		.000	.001
	N	124	124	124	123
3. Avoid Ambiguity	Pearson Correlation	.469**	.411**	1	.233**
	Sig. (2-tailed)	.000	.000		.009
	N	125	124	125	124
4. Knowledge is Certain	Pearson Correlation	.385**	.306**	.233**	1
	Sig. (2-tailed)	.000	.001	.009	
	N	124	123	124	124
5. Depend on Authority	Pearson Correlation	.328**	.333**	.284**	.216*
	Sig. (2-tailed)	.000	.000	.001	.016
	N	125	124	125	124
6. Don't Criticize Authority	Pearson Correlation	.415**	.392**	.282**	.365**
	Sig. (2-tailed)	.000	.000	.001	.000
	N	125	124	125	124
7. Ability to Learn	Pearson Correlation	.388**	.223*	.288**	.279**
	Sig. (2-tailed)	.000	.013	.001	.002
	N	125	124	125	124
8. Can't Learn How to Learn	Pearson Correlation	.139	.260**	.156	.222*
	Sig. (2-tailed)	.121	.003	.082	.013
	N	125	124	125	124
9. Success Not Hard Work	Pearson Correlation	.260**	.497**	.362**	.347**
	Sig. (2-tailed)	.003	.000	.000	.000
	N	125	124	125	124
10. Learn First Time	Pearson Correlation	.309**	.322**	.202*	.194*
	Sig. (2-tailed)	.000	.000	.024	.031
	N	125	124	125	124

11. Learn Quick	Pearson Correlation	.398**	.366**	.088	.383**
	Sig. (2-tailed)	.000	.000	.333	.000
	N	124	123	124	123
12. Concentrated Effort	Pearson Correlation	.365**	.300**	.337**	.127
	Sig. (2-tailed)	.000	.001	.000	.161
	N	125	124	125	124
1. Seek Single Answers	Pearson Correlation	.768**	.729**	.612**	.600**
	Sig. (2-tailed)	.000	.000	.000	.000

		5. Depend on Authority	6. Don't Criticize Authority	7. Ability to Learn	8. Can't Learn How to Learn
1. Seek Single Answers	Pearson Correlation	.328	.415**	.388**	.139**
	Sig. (2-tailed)	.000	.000	.000	.121
	N	125	125	125	125
2. Avoid Integration	Pearson Correlation	.333**	.392	.223**	.260**
	Sig. (2-tailed)	.000	.000	.013	.003
	N	124	124	124	124
3. Avoid Ambiguity	Pearson Correlation	.284**	.282**	.288	.156**
	Sig. (2-tailed)	.001	.001	.001	.082
	N	125	125	125	125
4. Knowledge is Certain	Pearson Correlation	.216**	.365**	.279**	.222
	Sig. (2-tailed)	.016	.000	.002	.013
	N	124	124	124	124
5. Depend on Authority	Pearson Correlation	1**	.449**	.316**	.090*
	Sig. (2-tailed)		.000	.000	.320
	N	125	125	125	125
6. Don't Criticize Authority	Pearson Correlation	.449**	1**	.265**	.144**
	Sig. (2-tailed)	.000		.003	.109
	N	125	125	125	125
7. Ability to Learn	Pearson Correlation	.316**	.265*	1**	-.059**
	Sig. (2-tailed)	.000	.003		.511
	N	125	125	125	125
8. Can't Learn How to Learn	Pearson Correlation	.090	.144**	-.059	1*

	Sig. (2-tailed)	.320	.109	.511	
	N	125	125	125	125
9. Success Not Hard Work	Pearson Correlation	.177**	.252**	.143**	.349**
	Sig. (2-tailed)	.049	.005	.112	.000
	N	125	125	125	125
10. Learn First Time	Pearson Correlation	.121**	.237**	.186*	.170*
	Sig. (2-tailed)	.179	.008	.038	.058
	N	125	125	125	125
11. Learn Quick	Pearson Correlation	.245**	.312**	.399	.048**
	Sig. (2-tailed)	.006	.000	.000	.596
	N	124	124	124	124
12. Concentrated Effort	Pearson Correlation	.274**	.177**	.141**	.075
	Sig. (2-tailed)	.002	.048	.117	.405
	N	125	125	125	125
13. SEBQ Total Score	Pearson Correlation	.581**	.634**	.518**	.373**
	Sig. (2-tailed)	.000	.000	.000	.000

		9. Success Not Hard Work	10. Learn First Time	11. Learn Quick	12. Concentrated Effort
1. Seek Single Answers	Pearson Correlation	.260	.309**	.398**	.365**
	Sig. (2-tailed)	.003	.000	.000	.000
	N	125	125	124	125
2. Avoid Integration	Pearson Correlation	.497**	.322	.366**	.300**
	Sig. (2-tailed)	.000	.000	.000	.001
	N	124	124	123	124
3. Avoid Ambiguity	Pearson Correlation	.362**	.202**	.088	.337**
	Sig. (2-tailed)	.000	.024	.333	.000
	N	125	125	124	125
4. Knowledge is Certain	Pearson Correlation	.347**	.194**	.383**	.127
	Sig. (2-tailed)	.000	.031	.000	.161
	N	124	124	123	124
5. Depend on Authority	Pearson Correlation	.177**	.121**	.245**	.274*
	Sig. (2-tailed)	.049	.179	.006	.002
	N	125	125	124	125

6. Don't Criticize Authority	Pearson Correlation	.252**	.237**	.312**	.177**
	Sig. (2-tailed)	.005	.008	.000	.048
	N	125	125	124	125
7. Ability to Learn	Pearson Correlation	.143**	.186*	.399**	.141**
	Sig. (2-tailed)	.112	.038	.000	.117
	N	125	125	124	125
8. Can't Learn How to Learn	Pearson Correlation	.349	.170**	.048	.075*
	Sig. (2-tailed)	.000	.058	.596	.405
	N	125	125	124	125
9. Success Not Hard Work	Pearson Correlation	1**	.146**	.232**	.200**
	Sig. (2-tailed)		.103	.009	.026
	N	125	125	124	125
10. Learn First Time	Pearson Correlation	.146**	1**	.189*	.188*
	Sig. (2-tailed)	.103		.035	.036
	N	125	125	124	125
11. Learn Quick	Pearson Correlation	.232**	.189**	1	.100**
	Sig. (2-tailed)	.009	.035		.270
	N	124	124	124	124
12. Concentrated Effort	Pearson Correlation	.200**	.188**	.100**	1
	Sig. (2-tailed)	.026	.036	.270	
	N	125	125	124	125
13. SEBQ Total Score	Pearson Correlation	.574**	.450**	.541**	.446**
	Sig. (2-tailed)	.000	.000	.000	.000

		13. SEBQ Total Score
1. Seek Single Answers	Pearson Correlation	.768
	Sig. (2-tailed)	.000
	N	122
2. Avoid Integration	Pearson Correlation	.729**
	Sig. (2-tailed)	.000
	N	122
3. Avoid Ambiguity	Pearson Correlation	.612**
	Sig. (2-tailed)	.000
	N	122
4. Knowledge is Certain	Pearson Correlation	.600**
	Sig. (2-tailed)	.000
	N	122

5. Depend on Authority	Pearson Correlation	.581**
	Sig. (2-tailed)	.000
	N	122
6. Don't Criticize Authority	Pearson Correlation	.634**
	Sig. (2-tailed)	.000
	N	122
7. Ability to Learn	Pearson Correlation	.518**
	Sig. (2-tailed)	.000
	N	122
8. Can't Learn How to Learn	Pearson Correlation	.373
	Sig. (2-tailed)	.000
	N	122
9. Success Not Hard Work	Pearson Correlation	.574**
	Sig. (2-tailed)	.000
	N	122
10. Learn First Time	Pearson Correlation	.450**
	Sig. (2-tailed)	.000
	N	122
11. Learn Quick	Pearson Correlation	.541**
	Sig. (2-tailed)	.000
	N	122
12. Concentrated Effort	Pearson Correlation	.446**
	Sig. (2-tailed)	.000
	N	122
13. SEBQ Total Score	Pearson Correlation	1**
	Sig. (2-tailed)	

	1. Seek Single Answers	2. Avoid Integration *n*	3. Avoid Ambiguity	4. Knowledge is Certain
13. SEBQ Total Score N	122	122**	122**	122**

	5. Depend on Authority	6. Don't Criticize Authority	7. Ability to Learn	8. Can't Learn How to Learn
13. SEBQ Total Score N	122	122**	122**	122**

	9. Success Not Hard Work	10. Learn First Time	11. Learn Quick	12. Concentrated Effort
13. SEBQ Total Score N	122	122**	122**	122**

		SEBQ_TotalScore
13. SEBQ Total Score	N	122

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

LPQ Bivariate Correlations

		1. Surface Motivation	2. Surface Approach	3. Deep Motivation	4. Deep Approach	5. Achievement Motivation	6. Achievement Approach	*7. Total Score* *LPQ*
1. Surface Motivation	Pearson Correlation	1	.034	.327**	.515**	-.010	.037	.497**
	Sig. (2-tailed)		.723	.000	.000	.919	.696	.000
	N	113	112	113	113	113	113	112
2. Surface Approach	Pearson Correlation	.034	1	.325**	-.031	.587**	.446**	.684**
	Sig. (2-tailed)	.723		.000	.741	.000	.000	.000
	N	112	113	113	113	113	113	112
3. Deep Motivation	Pearson Correlation	.327**	.325**	1	.137	.269**	.252**	.653**
	Sig. (2-tailed)	.000	.000		.146	.004	.007	.000
	N	113	113	114	114	114	114	112
4. Deep Approach	Pearson Correlation	.515**	-.031	.137	1	-.115	-.035	.384**
	Sig. (2-tailed)	.000	.741	.146		.221	.710	.000
	N	113	113	114	114	114	114	112
5. Achievement Motivation	Pearson Correlation	-.010	.587**	.269**	-.115	1	.447**	.628**
	Sig. (2-tailed)	.919	.000	.004	.221		.000	.000
	N	113	113	114	114	114	114	112
6. Achievement Approach	Pearson Correlation	.037	.446**	.252**	-.035	.447**	1	.636**
	Sig. (2-tailed)	.696	.000	.007	.710	.000		.000
	N	113	113	114	114	114	114	112
7. LPQ Total Score	Pearson Correlation	.497**	.684**	.653**	.384**	.628**	.636**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	
	N	112	112	112	112	112	112	112

**. Correlation is significant at the 0.01 level (2-tailed).

VNOS-C Bivariate Correlations

		Total VNOS-C	*Tentativeness*	*Nature &Scientific Observations Method*	
Total VNOS-C	Pearson Correlation	1	.506**	.589**	.468**
	Sig. (2-tailed)		.001	.000	.002
	N	43	43	43	43
Tentativeness	Pearson Correlation	.506**	1	.415**	.161
	Sig. (2-tailed)	.001		.006	.301
	N	43	44	43	43
Nature & Observations	Pearson Correlation	.589**	.415**	1	.253
	Sig. (2-tailed)	.000	.006		.102
	N	43	43	43	43
Scientific Method	Pearson Correlation	.468**	.161	.253	1
	Sig. (2-tailed)	.002	.301	.102	
	N	43	43	43	43
Theories & Laws	Pearson Correlation	.429**	.366*	.118	.253
	Sig. (2-tailed)	.004	.016	.452	.101
	N	43	43	43	43
Imagination	Pearson Correlation	.621**	.261	.214	.002
	Sig. (2-tailed)	.000	.087	.168	.990
	N	43	44	43	43
Validation	Pearson Correlation	.180	.095	-.044	.124
	Sig. (2-tailed)	.248	.543	.781	.429
	N	43	43	43	43
Subjectivity & Objectivity	Pearson Correlation	.842**	.419**	.605**	.341*
	Sig. (2-tailed)	.000	.005	.000	.025
	N	43	43	43	43

		Theories Laws	*&Imagination*	*Validation*	*Subjectivity & Objectivity*
Total VNOS-C	Pearson Correlation	.429	.621**	.180**	.842**
	Sig. (2-tailed)	.004	.000	.248	.000
	N	43	43	43	43
Tentativeness	Pearson Correlation	.366**	.261	.095**	.419
	Sig. (2-tailed)	.016	.087	.543	.005

	N	43	44	43	43
Nature & Observations	Pearson Correlation	.118**	.214**	-.044	.605
	Sig. (2-tailed)	.452	.168	.781	.000
	N	43	43	43	43
Scientific Method	Pearson Correlation	.253**	.002	.124	.341
	Sig. (2-tailed)	.101	.990	.429	.025
	N	43	43	43	43
Theories & Laws	Pearson Correlation	1**	.126*	.013	.194
	Sig. (2-tailed)		.422	.935	.213
	N	43	43	43	43
Imagination	Pearson Correlation	.126**	1	-.010	.727
	Sig. (2-tailed)	.422		.951	.000
	N	43	44	43	43
Validation	Pearson Correlation	.013	-.010	1	.222
	Sig. (2-tailed)	.935	.951		.152
	N	43	43	43	43
Subjectivity & Objectivity	Pearson Correlation	.194**	.727**	.222**	1*
	Sig. (2-tailed)	.213	.000	.152	
	N	43	43	43	43

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix D

SDEIQ ANOVA

Descriptive statistics

For the SDEIQ ANOVA, group 1 included 143 IB graduates and group 2 had 80 non-IB graduates.
The means and standard deviations for the IB and Non-IB diploma as well as the total score are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Diploma Group	*Mean*	*Std. Deviation*	*N*
IB Graduates	7.82	1.058	143
Non-IB Graduates	7.67	1.13	80
Total	7.76	1.08	223

Test of assumptions

Levene's Test of Equality of Error Variances was non-significant ($F(1, 221) = .056$, $p < .814$) meaning it is safe to assume homogeneity of variances in the data set.

Between-subject effects

ANOVA did not reveal a significant difference between groups ($F(1, 221) = 1.056$, $p < .305$, partial $\eta^2 = .005$). The ANOVA had weak power .176.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	1.229	1	1.229	1.056	.305	.005
Error	257.227	221	1.164			
Total	13702.478	223				

Estimated marginal means

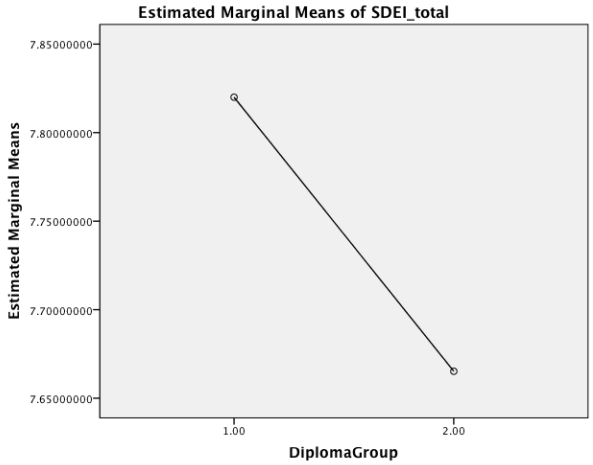
The following table provides the actual estimates, along with standard deviations and confidence intervals.

Diploma Group	*Mean*	*Std. Error*	*95% Confidence Interval*

			Lower Bound	Upper Bound
IB Graduates	7.82	.090	7.642	7.998
Non-IB Graduates	7.67	.121	7.428	7.903

Profile plots

Below is a plot of the estimated marginal means, which graphically demonstrates the lower average scores for the non-IB graduates compared to the IB graduates.



SDEIQ MANOVA

Descriptive statistics

For the SDEIQ MANOVA, group 1 included 143 IB graduates and group 2 had 80 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the totals for each factor are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

	Diploma Group	*Mean*	*Std. Deviation*	*N*
1. Interpretation and presentation of results	IB	4.01	.60	143
	Non-IB	3.91	.59	80
	Total	3.97	.60	223
2. Domain general strategies	IB	3.71	.66	143
	Non-IB	3.70	.75	80
	Total	3.70	.69	223
3. Data analysis	IB	3.93	.60	143
	Non-IB	3.93	.57	80

4. Self-regulatory strategies	Total	3.93	.59	223
	IB	4.19	.50	143
	Non-IB	4.18	.55	80
	Total	4.19	.512	223
5. Classroom cooperation behaviors	IB	3.79	.618	143
	Non-IB	3.61	.83	80
	Total	3.72	.70	223
6. Inquiry dispositions	IB	3.90	.78	143
	Non-IB	3.72	.63	80
	Total	3.84	.73	223
7. Inquiry small group collaboration behaviors	IB	3.82	.63	143
	Non-IB	3.69	.72	80
	Total	3.78	.66	223

Test of assumptions

Box's M	*54.676*
F	1.879
df1	28
df2	96043.771
Sig.	.003

	F	*df1*	*df2*	*Sig.*
1. Interpretation and presentation of results	.842	1	221	.360
2. Domain general strategies	2.075	1	221	.151
3. Data analysis	.294	1	221	.588
4. Self-regulatory strategies	.144	1	221	.705
5. Classroom cooperation behaviors	8.213	1	221	.005
6. Inquiry dispositions	6.318	1	221	.013
7. Inquiry small group collaboration behaviors	.532	1	221	.467

Multivariate tests

The multivariate test did not reveal a significant difference between groups ($\Lambda = .947,\ 7, 215) = 1.725,\ p < .104,$ partial $\eta^2 = .053$). The MANOVA had strong power .697.

Between-subject tests

The table of between-subject effects below shows that none of the tests revealed a significant difference between the two groups however all the effects are relatively small as can be note in the Partial Eta Squared column.

Source	*Dependent Variable*	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	1. Interpretation and presentation of results	.528	1	.528	1.479	.225	.007
	2. Domain general strategies	.004	1	.004	.009	.926	.000
	3. Data analysis	1.411E-005	1	1.411E-005	.000	.995	.000
	4. Self-regulatory strategies	.002	1	.002	.006	.940	.000
	5. Classroom cooperation behaviors	1.623	1	1.623	3.311	.070	.015
	6. Inquiry dispositions	1.588	1	1.588	2.980	.086	.013
	7. Inquiry small group collaboration behaviors	.907	1	.907	2.073	.151	.009

As can be seen in the table below, observed power for each factor was relatively weak. Factor 5 and 6 represent the variables with the strongest power.

Source	*Dependent Variable*	*Observed Power*
Diploma Group	1. Interpretation and presentation of results	.228
	2. Domain general strategies	.051
	3. Data analysis	.050
	4. Self-regulatory strategies	.051

	5. Classroom cooperation behaviors	.441
	6. Inquiry dispositions	.405
	7. Inquiry small group collaboration behaviors	.300

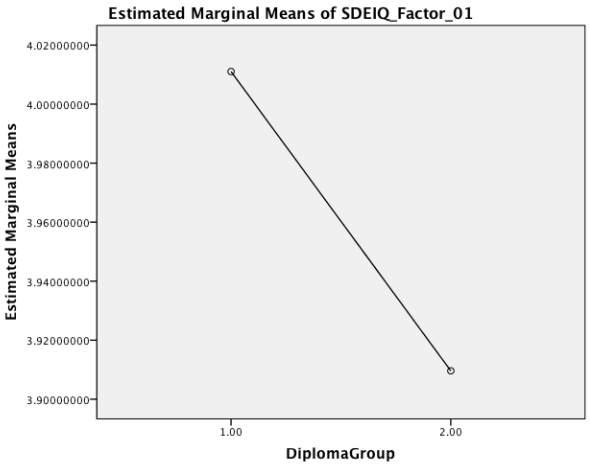
Estimated marginal means

Following is a table with the means, along with standard deviations and confidence intervals.

Dependent Variable	*Diploma Group*	*Mean*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	Upper Bound
1. Interpretation and presentation of results	IB	4.01	.050	3.913	4.109
	Non-IB	3.91	.067	3.778	4.041
2. Domain general strategies	IB	3.71	.058	3.593	3.821
	Non-IB	3.70	.078	3.545	3.851
3. Data analysis	IB	3.93	.049	3.836	4.031
	Non-IB	3.93	.066	3.804	4.064
4. Self-regulatory strategies	IB	4.19	.043	4.104	4.276
	Non-IB	4.18	.058	4.070	4.299
5. Classroom cooperation behaviors	IB	3.79	.059	3.672	3.903
	Non-IB	3.61	.078	3.456	3.764
6. Inquiry dispositions	IB	3.90	.061	3.781	4.021
	Non-IB	3.73	.082	3.564	3.886
7. Inquiry small group collaboration behaviors	IB	3.83	.055	3.716	3.934
	Non-IB	3.69	.074	3.546	3.838

Profile plots

Below are the plots of the estimated means. There is the same trend apparent across all 7 factors, except for factor 3, which is reversed.


Estimated Marginal Means of SDEIQ_Factor_01
Estimated Marginal Means
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4.00000000
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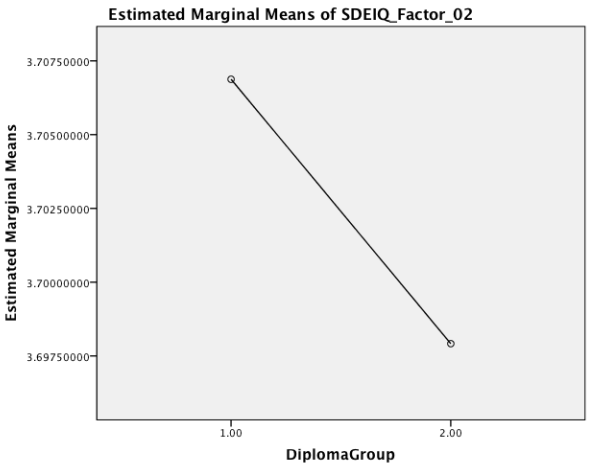
3.96000000
3.94000000
3.92000000
3.90000000
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SDEIQ_Factor_02
Estimated Marginal Means
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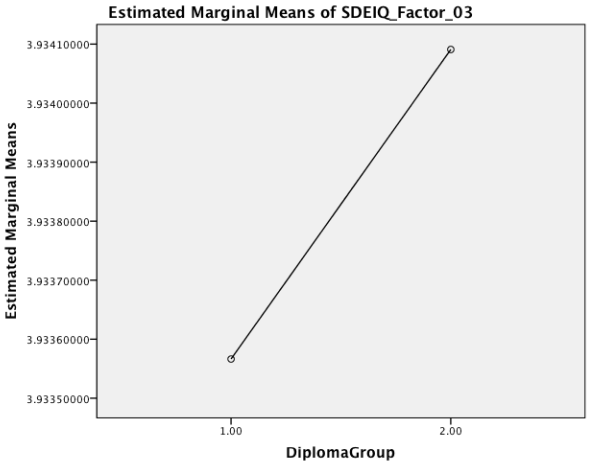
3.70500000
3.70250000
3.70000000
3.69750000
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SDEIQ_Factor_03
Estimated Marginal Means
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3.93390000
3.93380000
3.93370000
3.93360000
3.93350000
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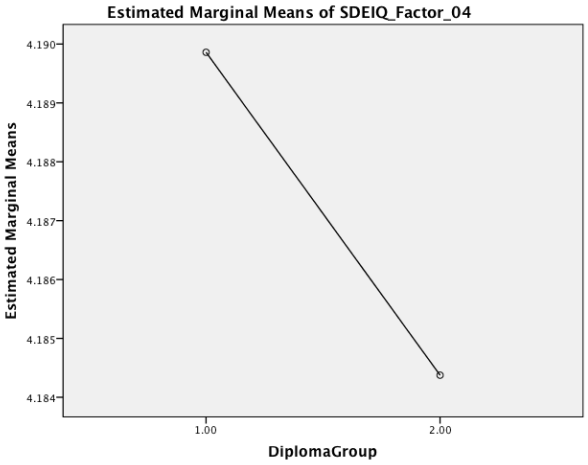
2.00
DiplomaGroup


Estimated Marginal Means of SDEIQ_Factor_04
Estimated Marginal Means
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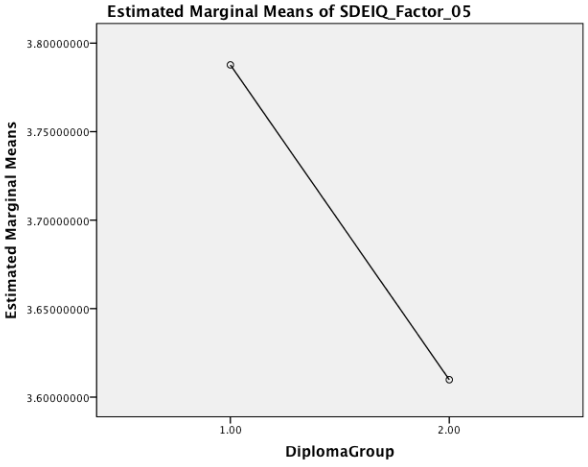
4.187
4.186
4.185
4.184
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SDEIQ_Factor_05
Estimated Marginal Means
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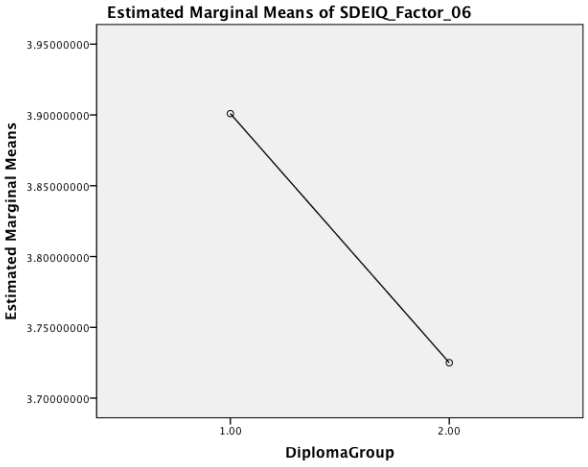
3.60000000
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SDEIQ_Factor_06
Estimated Marginal Means
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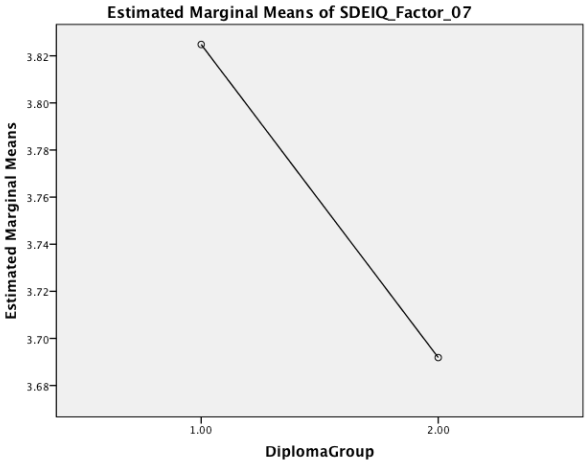
3.85000000
3.80000000
3.75000000
3.70000000
1.00
2.00
DiplomaGroup



MSDIQ ANOVA

Descriptive statistics

For the MSDIQ ANOVA, group 1 included 50 IB graduates and group 2 had 43 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the total score are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Diploma Group	*Mean*	*Std. Deviation*	*N*
IB Graduates	7.89	1.02	50
Non-IB Graduates	7.52	.88	43
Total	7.72	.97	93

Test of assumptions

Levene's Test of Equality of Error Variances was non-significant ($F(1, 91) = .695$, $p < .407$) meaning it is safe to assume homogeneity of variances in the data set.

Between-subject test

ANOVA did not reveal a significant difference between groups ($F(1, 91) = 3.462$, $p < .066$, partial $\eta^2 = .037$). The ANOVA had moderate power .453.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	3.163	1	3.163	3.461	.066	.037
Error	83.171	91	.914			
Total	5630.295	93				

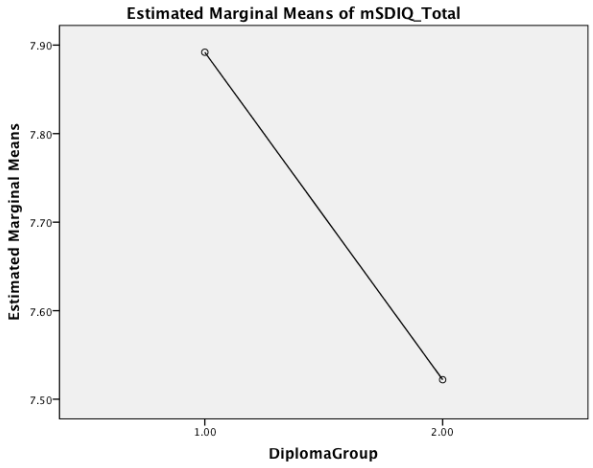
Estimated marginal means

Following is a table with the means, along with standard deviations and confidence intervals.

Diploma Group	*Mean*	*Std. Error*	*95% Confidence Interval*	
			Lower Bound	Upper Bound
IB Graduates	7.89	.135	7.623	8.161
Non-IB Graduates	7.52	.146	7.232	7.812

Profile plots

Below are the plots of the estimated means.



MSDIQ MANOVA

Descriptive statistics

For the MSDIQ MANOVA, group 1 included 49 IB graduates and group 2 had 43 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the totals for each factor are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

	Diploma Group	*Mean*	*Std. Deviation*	*N*
MsDIQ_FS1	1	8.65	1.51	49
	2	8.22	1.59	43
	Total	8.45	1.56	92
MsDIQ_FS2	1	8.36	1.85	49
	2	7.61	1.46	43
	Total	8.01	1.71	92
MsDIQ_FS3	1	7.48	1.70	49
	2	7.10	2.32	43
	Total	7.30	2.01	92
MsDIQ_FS4	1	6.92	1.94	49
	2	6.59	1.58	43
	Total	6.77	1.78	92
MsDIQ_FS5	1	7.76	1.74	49
	2	7.06	1.86	43
	Total	7.43	1.82	92
MsDIQ_FS6	1	7.38	1.97	49
	2	6.40	2.46	43
	Total	6.92	2.25	92
MsDIQ_FSDS1	1	7.56	1.90	49
	2	7.21	2.44	43
	Total	7.40	2.16	92
MsDIQ_FSDS2	1	7.68	1.51	49
	2	6.93	1.87	43
	Total	7.33	1.72	92
MsDIQ_FSDS3	1	8.29	1.52	49
	2	7.78	1.94	43
	Total	8.05	1.74	92
MsDIQ_FSDS4	1	7.91	1.80	49
	2	7.82	1.41	43
	Total	7.87	1.62	92
MsDIQ_FSDS5	1	7.78	1.93	49
	2	7.35	1.61	43
	Total	7.58	1.79	92
MsDIQ_FSDS6	1	7.88	1.92	49
	2	7.69	1.92	43
	Total	7.79	1.91	92
MsDIQ_FSDSR1	1	8.08	1.90	49
	2	7.17	1.35	43
	Total	7.66	1.72	92

Test of assumptions

While ANOVA/MANOVA are largely robust to violations of its core assumptions, normality, linearity, homoscedascity, homogeneity of variance, it is recommended to test against large departures from these assumptions.

Box's Test of Equality of Covariance Matrices was significant (M = 204.369, $F(91, 24502) = 1.900$, $p < .000$) suggesting that the assumption of the homogeneity of variances-covariances has been violated.

Equality of variances can be largely assumed for the factors as can be seen in the table below.

	F	*df1*	*df2*	*Sig.*
1. Inquiry Comprehension	.011	1	90	.915
2. Generative Inquiry	1.431	1	90	.235
3. Inquiry Planning	2.578	1	90	.112
4. Problem Solving	1.046	1	90	.309
5. Inquiry Teaching	.007	1	90	.935
6. Co-Construction of Inquiry	2.669	1	90	.106
7. Student Data Organization Strategies	.800	1	90	.373
8. Student Inquiry Communication Strategies	1.106	1	90	.296
9. Student Formal Reasoning Inquiry Strategies	.119	1	90	.731
10. Student Data Interpretation Strategies	1.095	1	90	.298
11. Student Self-Regulation Strategies for Inquiry Engagement	1.931	1	90	.168
12. Student Search Strategies	.033	1	90	.857
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	2.122	1	90	.149

Multivariate test

The multivariate test did not reveal a significant difference between groups ($\Lambda = .820$, $F(13, 78) = 1.321$, $p < .219$, partial $\eta^2 = .180$). The MANOVA had strong power .707.

Between-subject tests

The table of between-subject effects below shows that factors 2. Generative Inquiry, 6. Co-Construction of Inquiry, 8. Student Inquiry Communication Strategies and 13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences present a significant difference between the two groups however all the effects are relatively small as can be noted in the Partial Eta Squared column. Further, powers are weak across all the factors. The only exceptions being the two significant factors named above, which have the largest partial η^2 and the strong power.

Source	*Dependent Variable*	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	1. Inquiry Comprehension	4.204	1	4.204	1.748	.190	.019
	2. Generative Inquiry	12.806	1	12.806	4.556	.036	.048
	3. Inquiry Planning	3.244	1	3.244	.803	.373	.009
	4. Problem Solving	2.387	1	2.387	.750	.389	.008
	5. Inquiry Teaching	11.061	1	11.061	3.421	.068	.037
	6. Co-Construction of Inquiry	22.054	1	22.054	4.523	.036	.048
	7. Student Data Organization Strategies	2.871	1	2.871	.610	.437	.007
	8. Student Inquiry Communication Strategies	12.738	1	12.738	4.473	.037	.047
	9. Student Formal Reasoning Inquiry Strategies	5.844	1	5.844	1.955	.165	.021
	10. Student Data Interpretation Strategies	.162	1	.162	.061	.805	.001
	11. Student Self-Regulation Strategies for Inquiry Engagement	4.238	1	4.238	1.328	.252	.015
	12. Student Search Strategies	.806	1	.806	.219	.641	.002
	13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	19.222	1	19.222	6.898	.010	.071

Error	1. Inquiry Comprehension	216.463	90	2.405
	2. Generative Inquiry	252.967	90	2.811
	3. Inquiry Planning	363.637	90	4.040
	4. Problem Solving	286.451	90	3.183
	5. Inquiry Teaching	290.966	90	3.233
	6. Co-Construction of Inquiry	438.807a	90	4.876
	7. Student Data Organization Strategies	423.354b	90	4.704
	8. Student Inquiry Communication Strategies	256.324c	90	2.848
	9. Student Formal Reasoning Inquiry Strategies	268.996d	90	2.989
Error	10. Student Data Interpretation Strategies	237.954e	90	2.644
	11. Student Self-Regulation Strategies for Inquiry Engagement	287.190f	90	3.191
	12. Student Search Strategies	331.238g	90	3.680
	13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	250.808h	90	2.787
Total	1. Inquiry Comprehension	6790.654i	92	
	2. Generative Inquiry	6163.938j	92	

	3. Inquiry Planning	5275.627k	92
	4. Problem Solving	4500.058l	92
	5. Inquiry Teaching	5383.189m	92
	6. Co-Construction of Inquiry	4866.259	92
	7. Student Data Organization Strategies	5458.749	92
	8. Student Inquiry Communication Strategies	5213.081	92
	9. Student Formal Reasoning Inquiry Strategies	6235.265	92
	10. Student Data Interpretation Strategies	5935.317	92
	11. Student Self-Regulation Strategies for Inquiry Engagement	5581.566	92
	12. Student Search Strategies	5915.674	92
	13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	5663.460	92
Corrected Total	1. Inquiry Comprehension	220.667	91
	2. Generative Inquiry	265.773	91
	3. Inquiry Planning	366.880	91
	4. Problem Solving	288.838	91

	5. Inquiry Teaching	302.027	91
	6. Co-Construction of Inquiry	460.861	91
	7. Student Data Organization Strategies	426.225	91
	8. Student Inquiry Communication Strategies	269.062	91
	9. Student Formal Reasoning Inquiry Strategies	274.841	91
	10. Student Data Interpretation Strategies	238.116	91
	11. Student Self-Regulation Strategies for Inquiry Engagement	291.428	91
	12. Student Search Strategies	332.044	91
	13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	270.030	91

Source	Dependent Variable	Observed Power
Diploma Group	1. Inquiry Comprehension	.258
	2. Generative Inquiry	.560
	3. Inquiry Planning	.144
	4. Problem Solving	.137
	5. Inquiry Teaching	.448
	6. Co-Construction of Inquiry	.557
	7. Student Data Organization Strategies	.121

8. Student Inquiry Communication Strategies	.553
9. Student Formal Reasoning Inquiry Strategies	.283
10. Student Data Interpretation Strategies	.057
11. Student Self-Regulation Strategies for Inquiry Engagement	.207
12. Student Search Strategies	.075
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	.738

Parameter Estimates

Dependent Variable	*Parameter*	*B*	*Std. Error*	*t*	*Sig.*	*95% Confidence Interval*	
						Lower Bound	Upper Bound
1. Inquiry Comprehension	Intercept	8.222	.237	34.767	.000	7.753	8.692
	IB Graduates	.428	.324	1.322	.190	-.215	1.072
	Non-IB Graduates	0a	.	.	.	.	.
2. Generative Inquiry	Intercept	7.609	.256	29.760	.000	7.101	8.117
	IB Graduates	.748	.350	2.135	.036	.052	1.444
	Non-IB Graduates	0a	.	.	.	.	.
3. Inquiry Planning	Intercept	7.104	.307	23.175	.000	6.495	7.713
	IB Graduates	.376	.420	.896	.373	-.458	1.211
	Non-IB Graduates	0a	.	.	.	.	.
4. Problem Solving	Intercept	6.594	.272	24.236	.000	6.053	7.134
	IB Graduates	.323	.373	.866	.389	-.418	1.063
	Non-IB Graduates	0a	.	.	.	.	.
5. Inquiry Teaching	Intercept	7.062	.274	25.753	.000	6.517	7.606
	IB Graduates	.695	.376	1.850	.068	-.051	1.441
	Non-IB Graduates	0a	.	.	.	.	.
6. Co-Construction of	Intercept	6.397	.337	18.998	.000	5.728	7.066
	IB Graduates	.981	.461	2.127	.036	.065	1.898

Inquiry	Non-IB Graduates	0a	.	.	.	.	.
7. Student Data Organization Strategies	Intercept	7.207	.331	21.791	.000	6.550	7.865
	IB Graduates	.354	.453	.781	.437	-.546	1.254
	Non-IB Graduates	0a	.	.	.	.	.
8. Student Inquiry Communication Strategies	Intercept	6.933	.257	26.941	.000	6.422	7.445
	IB Graduates	.746	.353	2.115	.037	.045	1.446
	Non-IB Graduates	0a	.	.	.	.	.
9. Student Formal Reasoning Strategies	Intercept	7.780	.264	29.510	.000	7.256	8.304
	IB Graduates	.505	.361	1.398	.165	-.213	1.223
	Non-IB Graduates	0a	.	.	.	.	.
10. Student Data Interpretation Strategies	Intercept	7.824	.248	31.555	.000	7.332	8.317
	IB Graduates	.084	.340	.248	.805	-.591	.759
	Non-IB Graduates	0a	.	.	.	.	.
11. Student Self-Regulation Strategies for Inquiry Engagement	Intercept	7.354	.272	26.995	.000	6.813	7.895
	IB Graduates	.430	.373	1.152	.252	-.311	1.172
	Non-IB Graduates	0a	.	.	.	.	.
12. Student Search Strategies	Intercept	7.691	.293	26.287	.000	7.109	8.272
	IB Graduates	.188	.401	.468	.641	-.609	.984
	Non-IB Graduates	0a	.	.	.	.	.
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	Intercept	7.169	.255	28.160	.000	6.663	7.674
	IB Graduates	.916	.349	2.626	.010	.223	1.609
	Non-IB Graduates	0a	.	.	.	.	.

Dependent Variable	*Parameter*	*Partial Eta Squared*	*Observed Power*
1. Inquiry Comprehension	Intercept	.931	1.000
	IB Graduates	.019	.258
	Non-IB Graduates	.a	.
2. Generative Inquiry	Intercept	.908	1.000
	IB Graduates	.048	.560
	Non-IB Graduates	.a	.
3. Inquiry Planning	Intercept	.856	1.000
	IB Graduates	.009	.144
	Non-IB Graduates	.a	.

4. Problem Solving	Intercept	.867	1.000
	IB Graduates	.008	.137
	Non-IB Graduates	.a	.
5. Inquiry Teaching	Intercept	.881	1.000
	IB Graduates	.037	.448
	Non-IB Graduates	.a	.
6. Co-Construction of Inquiry	Intercept	.800	1.000
	IB Graduates	.048	.557
	Non-IB Graduates	.a	.
7. Student Data Organization Strategies	Intercept	.841	1.000
	IB Graduates	.007	.121
	Non-IB Graduates	.a	.
8. Student Inquiry Communication Strategies	Intercept	.890	1.000
	IB Graduates	.047	.553
	Non-IB Graduates	.a	.
9. Student Formal Reasoning Strategies	Intercept	.906	1.000
	IB Graduates	.021	.283
	Non-IB Graduates	.a	.
10. Student Data Interpretation Strategies	Intercept	.917	1.000
	IB Graduates	.001	.057
	Non-IB Graduates	.a	.
11. Student Self-Regulation Strategies for Inquiry Engagement	Intercept	.890	1.000
	IB Graduates	.015	.207
	Non-IB Graduates	.a	.
12. Student Search Strategies	Intercept	.885	1.000
	IB Graduates	.002	.075
	Non-IB Graduates	.a	.
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	Intercept	.898	1.000
	IB Graduates	.071	.738
	Non-IB Graduates	.a	.

Estimated marginal means

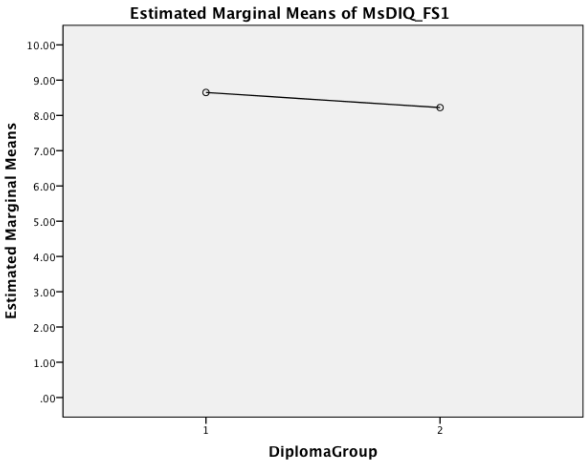
Following is a table with the means, along with standard deviations and confidence intervals.

Dependent Variable	*Diploma Group*	*Mean*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	Upper Bound
1. Inquiry Comprehension	IB Graduates	8.65	.22	8.211	9.091
	Non-IB Graduates	8.22	.24	7.753	8.692

2. Generative Inquiry	IB Graduates	8.36	.24	7.881	8.832
	Non-IB Graduates	7.61	.26	7.101	8.117
3. Inquiry Planning	IB Graduates	7.48	.29	6.910	8.051
	Non-IB Graduates	7.10	.31	6.495	7.713
4. Problem Solving	IB Graduates	6.92	.26	6.410	7.423
	Non-IB Graduates	6.59	.27	6.053	7.134
5. Inquiry Teaching	IB Graduates	7.76	.26	7.246	8.267
	Non-IB Graduates	7.06	.27	6.517	7.606
6. Co-Construction of Inquiry	IB Graduates	7.38	.32	6.752	8.005
	Non-IB Graduates	6.40	.34	5.728	7.066
7. Student Data Organization Strategies	IB Graduates	7.56	.31	6.946	8.177
	Non-IB Graduates	7.21	.33	6.550	7.865
8. Student Inquiry Communication Strategies	IB Graduates	7.68	.24	7.200	8.158
	Non-IB Graduates	6.93	.26	6.422	7.445
9. Student Formal Reasoning Inquiry Strategies	IB Graduates	8.29	.25	7.794	8.776
	Non-IB Graduates	7.78	.26	7.256	8.304
10. Student Data Interpretation Strategies	IB Graduates	7.91	.23	7.447	8.370
	Non-IB Graduates	7.82	.25	7.332	8.317
11. Student Self-Regulation Strategies for Inquiry Engagement	IB Graduates	7.78	.26	7.277	8.291
	Non-IB Graduates	7.35	.27	6.813	7.895
12. Student Search Strategies	IB Graduates	7.88	.27	7.334	8.423
	Non-IB Graduates	7.69	.29	7.109	8.272
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	IB Graduates	8.09	.24	7.611	8.559
	Non-IB Graduates	7.17	.26	6.663	7.674

Profile plots

Below are the plots of the estimated means. The same trend is apparent across all the 13 factors.


Estimated Marginal Means of MsDIQ_FS1
Estimated Marginal Means
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2.00
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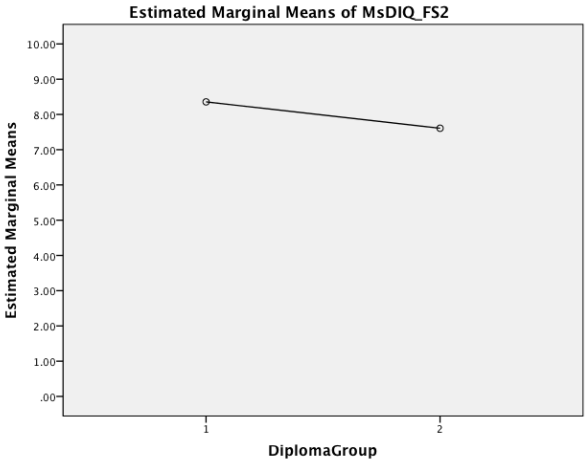
2
DiplomaGroup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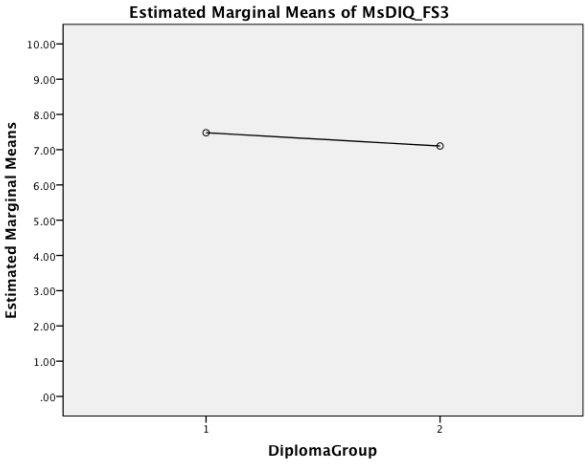
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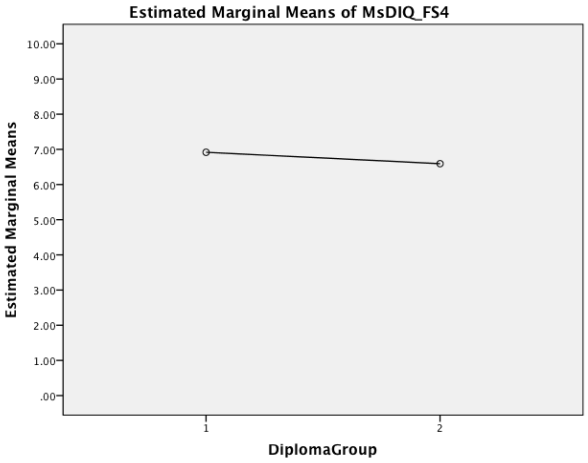
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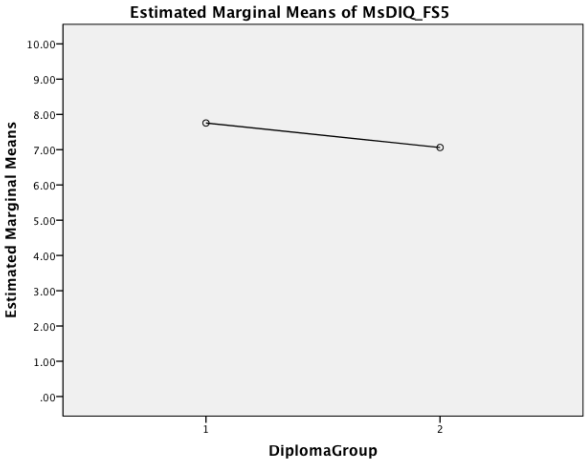
DiplomaGroup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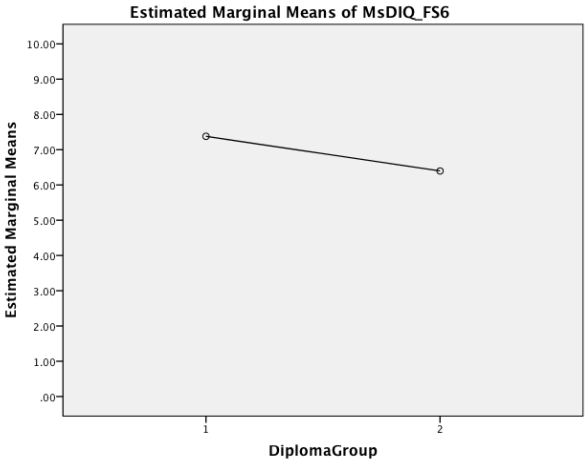
DiplomaGroup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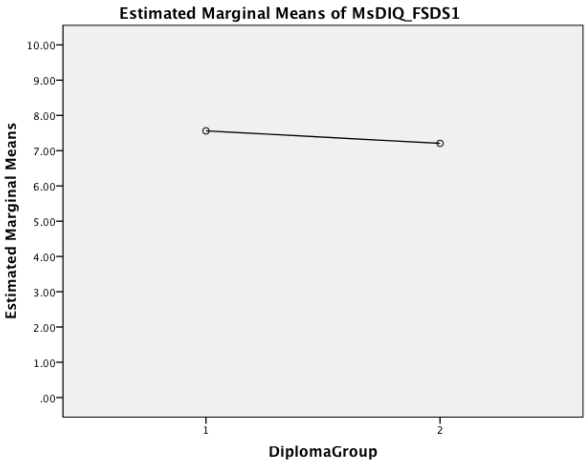
2
DiplomaGroup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Estimated Marginal Means
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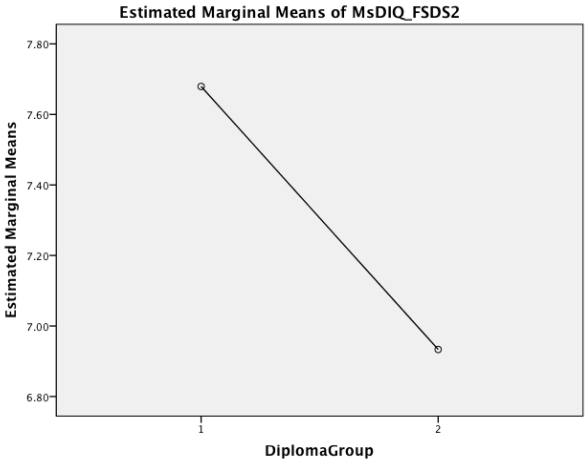
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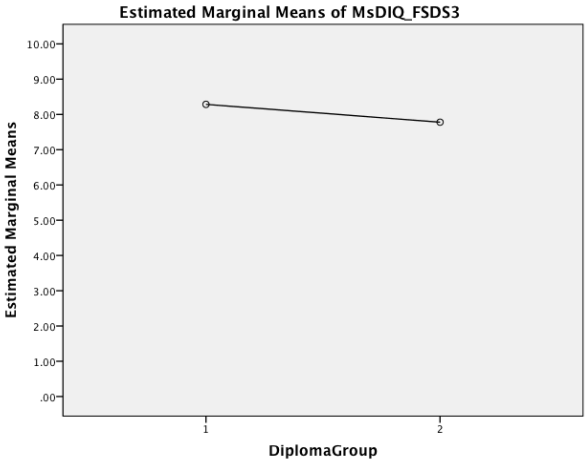
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1.00
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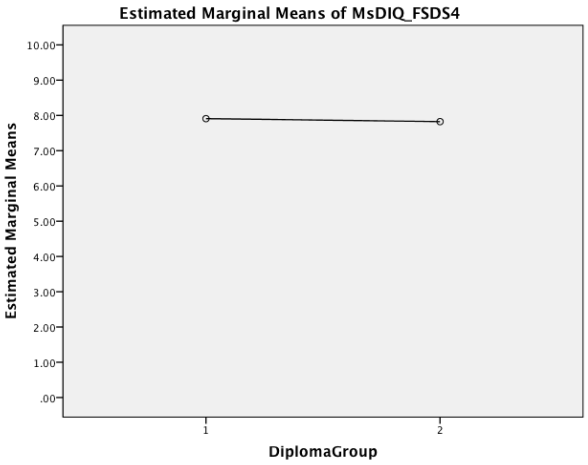
2
DiplomaGroup


Estimated Marginal Means of MsDIQ_FSDS4
Estimated Marginal Means
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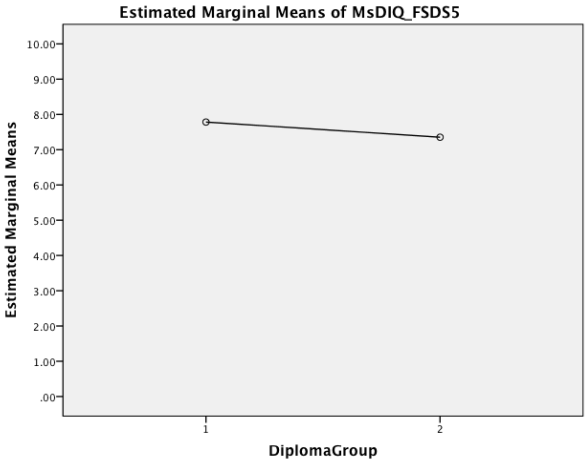
2
DiplomaGroup


Estimated Marginal Means of MsDIQ_FSDS5
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5.00
4.00
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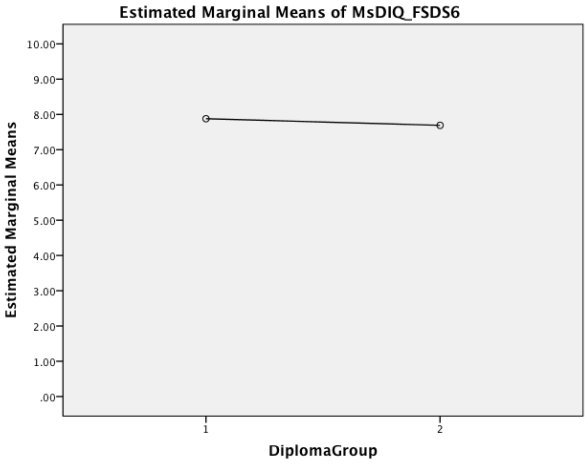
2.00
1.00
.00
1
2
DiplomaGroup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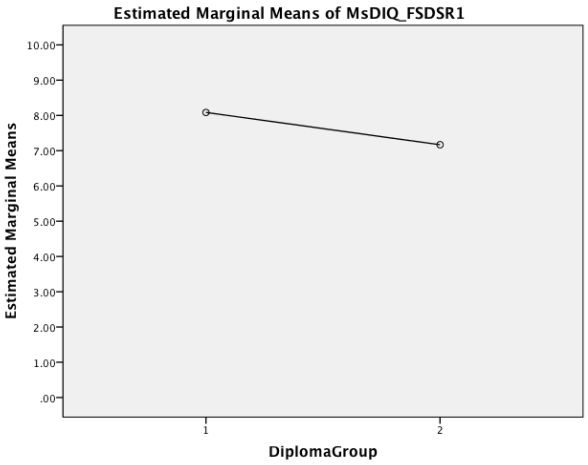
2
DiplomaGroup



SEBQ ANOVA

Descriptive statistics

For the SDEIQ ANOVA, group 1 included 68 IB graduates and group 2 had 54 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the total score are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Test of assumptions

Levene's test of equality of error variances was not significant ($F(1, 120) = .544$, $p < .462$) meaning it is safe to assume homogeneity of variances in the data set.

Between-subject effects

ANOVA did not reveal a significant difference between groups ($F(1, 120) = .129$, $p < .720$, partial $\eta^2 = .001$). The ANOVA had weak power .065.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	.013	1	.013	.129	.720	.001
Error	11.663	120	.097			
Total	1131.786	122				

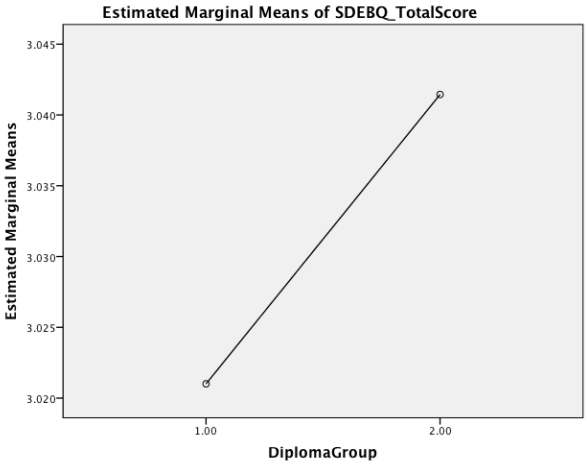
Estimated marginal means

The following table provides the estimates, along with standard deviations and confidence intervals.

Diploma Group	*Mean*	*Std. Error*	*95% Confidence Interval*	
			Lower Bound	Upper Bound
IB Graduates			2.946	3.096
Non-IB Graduates			2.957	3.125

Profile plots

Below is a plot of the estimated marginal mean, which graphically demonstrates the lower average score for the IB graduates compared to the non-IB graduates.



SEBQ MANOVA

Descriptive statistics

For the MISEQ MANOVA, group 1 included 68 IB graduates and group 2 had 54 non-IB graduates.
The means and standard deviations for the IB and Non-IB diploma as well as the

totals for each factor are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Test of assumptions

Box's Test of Equality of Covariance Matrices was significant (M = 87.80, $F(78, 40878) = 1.005$, $p < .467$) suggesting that the assumption of the homogeneity of variances-covariances is tenable.

	F	*df1*	*df2*	*Sig.*
1. Seek Single Answers	.606	1	120	.438
2. Avoid Integration	1.569	1	120	.213
3. Avoid Ambiguity	.670	1	120	.415
4. Knowledge Certain	4.531	1	120	.035
5. Depend Authority	1.264	1	120	.263
6. Don't Criticize Authority	.135	1	120	.714
7. Ability Learn	.777	1	120	.380
8. Can't Learn How to Learn	.557	1	120	.457
9. Success Not Hard Work	.452	1	120	.503
10. Learn First Time	1.168	1	120	.282
11. Learn Quick	7.598	1	120	.007
12. Concentrated Effort	.227	1	120	.634

Multivariate test

The multivariate test revealed a significant difference between groups ($\Lambda = .744$, $F(12, 109) = 3.131$, $p < .001$, partial $\eta^2 = .256$). The MANOVA had strong power .990.

The table of between-subject effects below shows that factors 4, 5, and 11 present significant differences between the two groups however all the effects are relatively small as can be note in the Partial Eta Squared column of the following table. As can be seen in the same table, observed power for each factor was relatively weak. Factor 4, 5, and 11 represent the variables with the strongest power.

Source	*Dependent Variable*	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
	1. Seek Single Answers	.114	1	.114	.563	.455
	2. Avoid Integration	.007	1	.007	.031	.861
	3. Avoid Ambiguity	.938	1	.938	2.565	.112
	4. Knowledge Certain	.983	1	.983	3.963	.049
	5. Depend Authority	1.887	1	1.887	4.231	.042
Diploma Group	6. Don't Criticize Authority	.402a	1	.402	2.079	.152
	7. Ability Learn	.076b	1	.076	.185	.668

	8. Can't Learn How to Learn	.171c	1	.171	.594	.442
	9. Success Not Hard Work	.361d	1	.361	1.217	.272
	10. Learn First Time	.048e	1	.048	.175	.676
	11. Learn Quick	2.302f	1	2.302	13.039	.000
	12. Concentrated Effort	1.686g	1	1.686	2.881	.092
Error	1. Seek Single Answers	24.346h	120	.203		
	2. Avoid Integration	25.832i	120	.215		
	3. Avoid Ambiguity	43.909j	120	.366		
	4. Knowledge Certain	29.771k	120	.248		
	5. Depend Authority	53.533l	120	.446		
	6. Don't Criticize Authority	23.196	120	.193		
	7. Ability Learn	49.635	120	.414		
	8. Can't Learn How to Learn	34.557	120	.288		
	9. Success Not Hard Work	35.556	120	.296		
	10. Learn First Time	33.205	120	.277		
	11. Learn Quick	21.189	120	.177		
	12. Concentrated Effort	70.218	120	.585		
Total	1. Seek Single Answers	1090.890	122			
	2. Avoid Integration	1162.422	122			
	3. Avoid Ambiguity	1130.880	122			
	4. Knowledge Certain	1113.806	122			
	5. Depend Authority	1183.625	122			
	6. Don't Criticize Authority	936.167	122			
	7. Ability Learn	857.875	122			
	8. Can't Learn How to Learn	1696.040	122			
	9. Success Not Hard Work	1570.938	122			
	10. Learn First Time	944.000	122			
	11. Learn Quick	1092.880	122			
	12. Concentrated Effort	1131.250	122			

Source	*Dependent Variable*	*Partial Eta Squared*	*Observed Power*
Diploma Group	1. Seek Single Answers	.005	.115
	2. Avoid Integration	.000	.053
	3. Avoid Ambiguity	.021	.355
	4. Knowledge Certain	.032	.506
	5. Depend Authority	.034	.532

	6. Don't Criticize Authority	.017	.299
	7. Ability Learn	.002	.071
	8. Can't Learn How to Learn	.005	.119
	9. Success Not Hard Work	.010	.195
	10. Learn First Time	.001	.070
	11. Learn Quick	.098	.948
	12. Concentrated Effort	.023	.391

Estimated marginal means

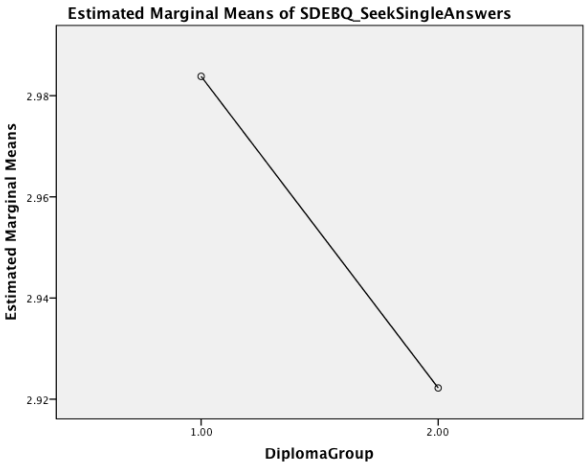
Following is a table with the means, along with standard deviations and confidence intervals.

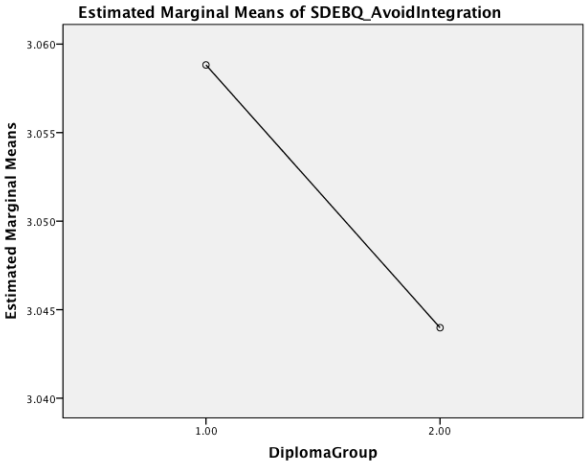
Dependent Variable	*Diploma Group*	*Mean*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	Upper Bound
Seek Single Answers	IB Graduates	2.98	.06	2.876	3.092
	Non-IB Graduates	2.92	.06	2.801	3.044
Avoid Integration	IB Graduates	3.06	.06	2.947	3.170
	Non-IB Graduates	3.04	.06	2.919	3.169
Avoid Ambiguity	IB Graduates	3.06	.07	2.917	3.207
	Non-IB Graduates	2.89	.08	2.722	3.048
Knowledge Certain	IB Graduates	2.90	.06	2.780	3.019
	Non-IB Graduates	3.08	.07	2.946	3.214
Depend Authority	IB Graduates	2.93	.08	2.770	3.091
	Non-IB Graduates	3.18	.09	3.001	3.361
Don't Criticize Authority	IB Graduates	2.68	.05	2.578	2.789
	Non-IB Graduates	2.80	.06	2.681	2.918
Ability Learn	IB Graduates	2.55	.08	2.397	2.706
	Non-IB Graduates	2.60	.09	2.429	2.775
Can't Learn How to Learn	IB Graduates	3.72	.07	3.595	3.852
	Non-IB Graduates	3.65	.07	3.504	3.793
Success Not Hard Work	IB Graduates	3.60	.07	3.465	3.726
	Non-IB Graduates	3.49	.07	3.339	3.633
Learn First Time	IB Graduates	2.75	.06	2.624	2.876
	Non-IB Graduates	2.71	.07	2.568	2.852
Learn Quick	IB Graduates	2.84	.05	2.737	2.939
	Non-IB Graduates	3.12	.07	3.002	3.228
Concentrated Effort	IB Graduates	3.05	.09	2.868	3.235
	Non-IB Graduates	2.82	.10	2.609	3.021

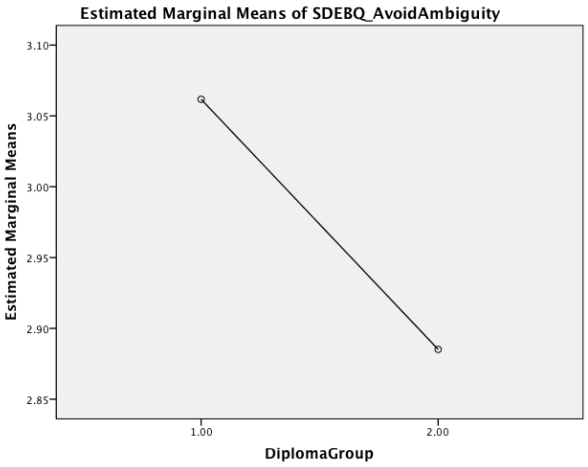
Profile plots

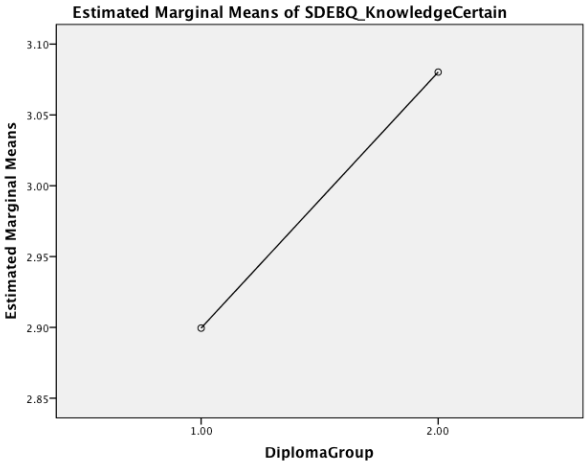
Below are the plots of the estimated means. There is an alternating trend apparent

across all 12 factors.








Estimated Marginal Means of SDEBQ_KnowledgeCertain
Estimated Marginal Means
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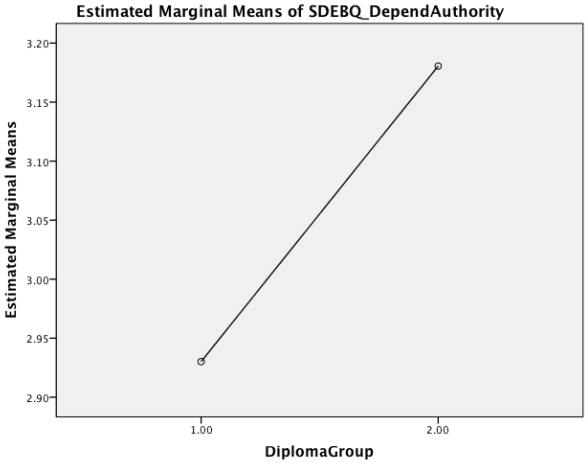
2.00
DiplomaGroup


Estimated Marginal Means of SDEBQ_DependAuthority
Estimated Marginal Means
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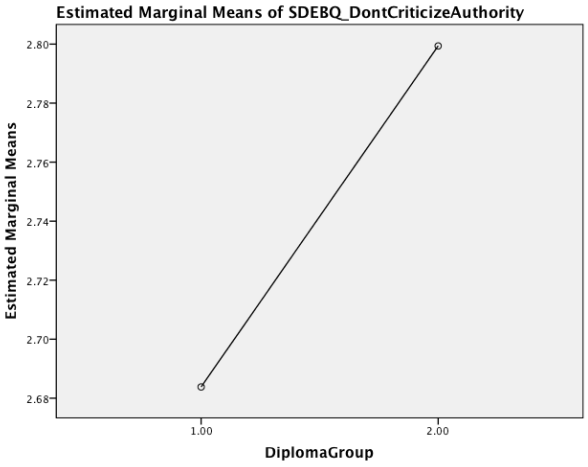
2.00
DiplomaGroup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Estimated Marginal Means
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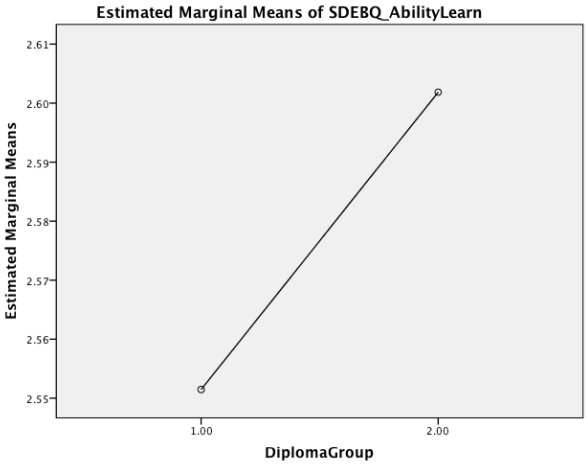
DiplomaGroup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Estimated Marginal Means
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2.56
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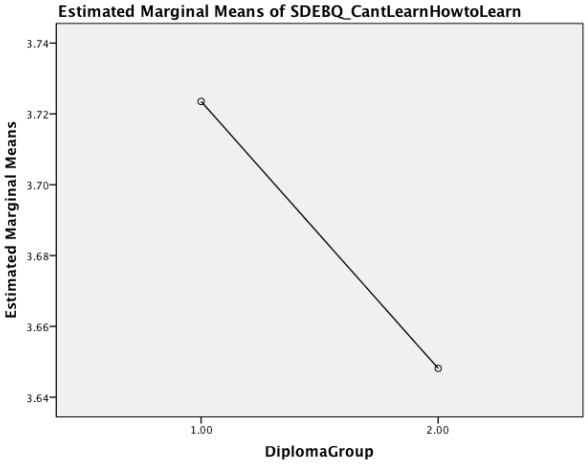
2.00
DiplomaGroup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Estimated Marginal Means
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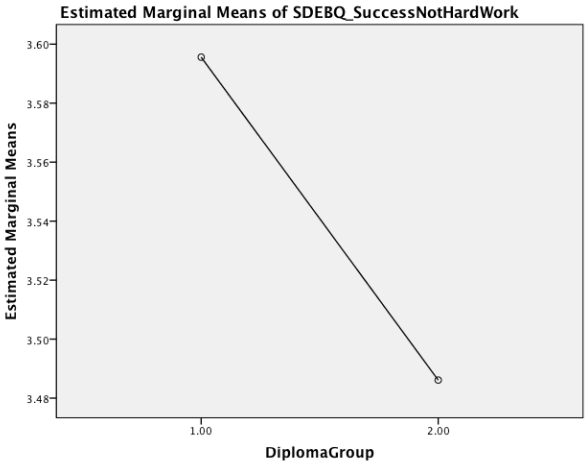
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Estimated Marginal Means
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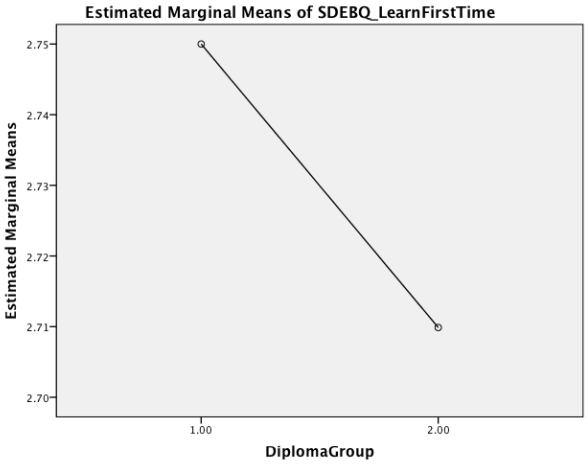
Estimated Marginal Means of SDEBQ_LearnFirstTime
Estimated Marginal Means
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2.74
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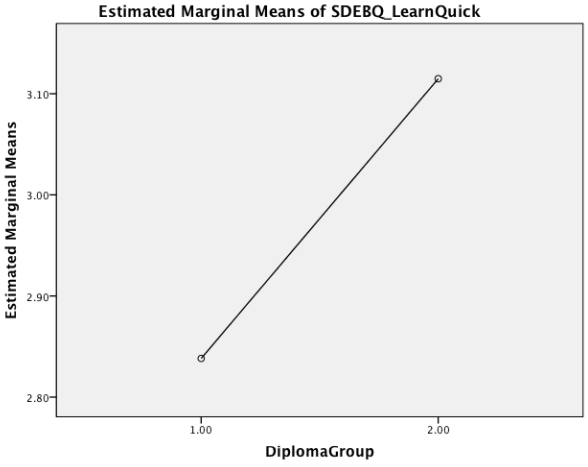
2.72
2.71
2.70
1.00
2.00
DiplomaGroup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Estimated Marginal Means
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2.80
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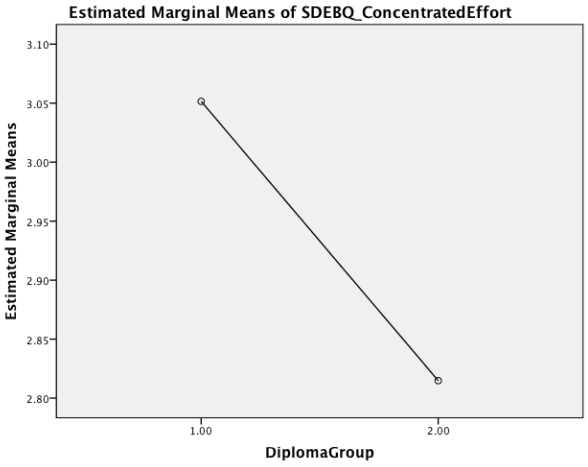
2.00
DiplomaGroup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Estimated Marginal Means
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2.90
2.85
2.80
1.00
2.00
DiplomaGroup

LPQ ANOVA

Descriptive statistics

For the LPQ ANOVA, group 1 included 61 IB graduates and group 2 had 51 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the total score are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Test of assumptions

Levene's Test of Equality of Error Variances was non-significant ($F(2, 110) = .098$, $p < .754$) meaning it is safe to assume homogeneity of variances in the data set.

Between-subject effects

ANOVA did not reveal a significant difference between groups ($F(1, 112) = .222$, $p < .638$ partial $\eta^2 = .002$). The ANOVA had weak power .075.

Estimated marginal means

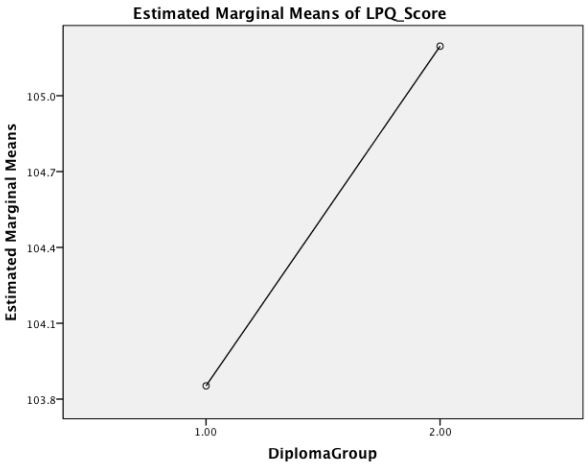
Following is a table with the means, along with standard deviations and confidence intervals.

Diploma Group	*Mean*	*Std. Error*	*95% Confidence Interval*	
			Lower Bound	Upper Bound
IB Graduates			100.042	107.663
Non-IB Graduates			101.029	109.364

Profile plots

Below is the plot of the estimated means, which shows the lower average scores for

IB graduates versus non-IB graduates.



LPQ MANOVA

Descriptive statistics

For the MSDIQ MANOVA, group 1 included 61 IB graduates and group 2 had 51 non-IB graduates.
The means and standard deviations for the IB and Non-IB diploma as well as the totals for each factor are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

	Diploma Group	*Mean*	*Std. Deviation*	*N*
Surface Motive	IB Graduates	15.46	3.60	61
	Non-IB Graduates	16.96	3.85	51
	Total	16.14	3.77	112
Surface Approach	IB Graduates	15.93	4.02	61
	Non-IB Graduates	15.96	4.35	51
	Total	15.95	4.15	112
Deep Motive	IB Graduates	15.51	4.62	61
	Non-IB Graduates	15.41	4.35	51
	Total	15.46	4.48	112
Deep Approach	IB Graduates	20.82	4.04	61
	Non-IB Graduates	22.27	4.23	51
	Total	21.48	4.17	112
Achievement Motive	IB Graduates	16.92	3.90	61
	Non-IB Graduates	15.75	4.56	51
	Total	16.38	4.24	112
Achievement Approach	IB Graduates	19.21	4.80	61
	Non-IB Graduates	18.84	4.87	51

	Total	19.04	4.81	112

Test of assumptions

Neither Box's Test of Equality of Covariance Matrices nor Levene's test of equality of variance reported a significant result suggesting that the assumptions of the homogeneity of variances-covariances and homoscedascity are tenable.

Box's Test of Equality of Covariance Matrices

Box's M	*17.235*
F	.772
df1	21
df2	41592.686
Sig.	.757

Levene's Test of Equality of Error Variances

	F	*df1*	*df2*	*Sig.*
Surface Motive	.440	1	110	.509
Surface Approach	1.640	1	110	.203
Deep Motive	.653	1	110	.421
Deep Approach	.001	1	110	.978
Achievement Motive	2.710	1	110	.103
Achievement Approach	.009	1	110	.925

Multivariate test

The multivariate test revealed a significant difference between groups ($\Lambda = .925$, $F(6, 105) = 1.418$, $p < .214$, partial $\eta^2 = .075$). The MANOVA had moderate power .532.

Between-subject effects

The table of between-subject effects below shows that none of the tests except for 1. Surface Motivation presents a significant difference between the two groups however all the effects are relatively small as can be noted in the Partial Eta Squared column. Further, powers are weak across all the factors.

Source	*Dependent Variable*	*Type III Sumdf of Squares*		*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	1. Surface Motivation	62.645	1	62.645	4.542	.035	.040

	2. Surface Approach	.019	1	.019	.001	.974	.000
	3. Deep Motivation	.258	1	.258	.013	.910	.000
	4. Deep Approach	58.791	1	58.791	3.456	.066	.030
	5. Achievement Motivation	38.215	1	38.215	2.151	.145	.019
	6. Achievement Approach	3.802	1	3.802	.163	.687	.001
Error	1. Surface Motivation	1517.069	110	13.792			
	2. Surface Approach	1915.659	110	17.415			
	3. Deep Motivation	2225.599	110	20.233			
	4. Deep Approach	1871.173	110	17.011			
	5. Achievement Motivation	1954.276	110	17.766			
	6. Achievement Approach	2566.975	110	23.336			
Total	1. Surface Motivation	30766.000	112				
	2. Surface Approach	30396.000	112				
	3. Deep Motivation	29010.000	112				
	4. Deep Approach	53616.000	112				
	5. Achievement Motivation	32057.000	112				
	6. Achievement Approach	43193.000	112				

Source	*Dependent Variable*	*Observed Power*
Diploma Group	1. Surface Motivation	.561
	2. Surface Approach	.050
	3. Deep Motivation	.051
	4. Deep Approach	.453
	5. Achievement Motivation	.307
	6. Achievement Approach	.069

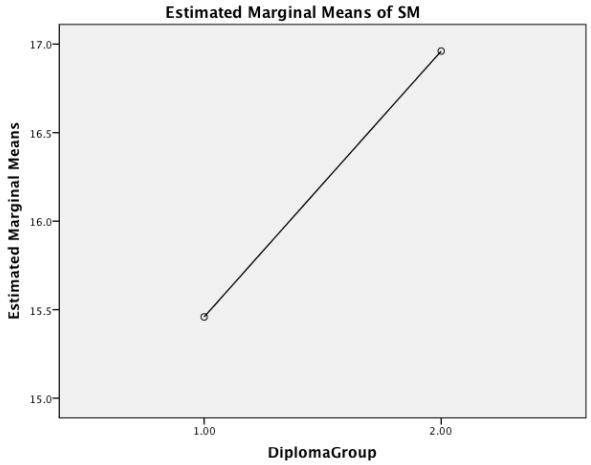
Estimated marginal means

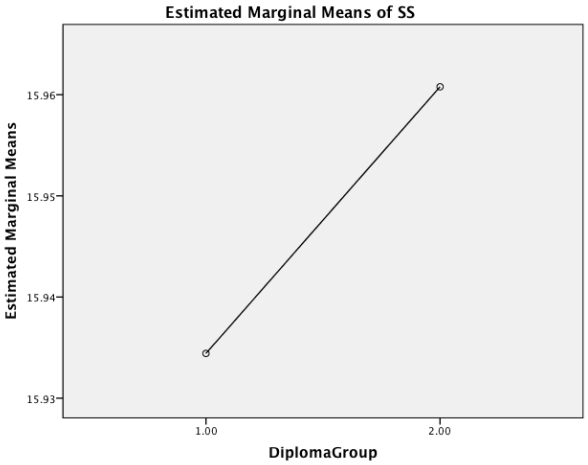
Following is a table with the means, along with standard deviations and confidence intervals.

Dependent Variable	*Diploma Group*	*Mean*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	Upper Bound
1. Surface Motivation	IB	15.46	.475	14.517	16.401
	Non-IB	16.961	.520	15.930	17.991
2. Surface Approach	IB	15.934	.534	14.876	16.993
	Non-IB	15.961	.584	14.803	17.119
3. Deep Motivation	IB	15.508	.576	14.367	16.650
	Non-IB	15.412	.630	14.164	16.660
4. Deep Approach	IB	20.820	.528	19.773	21.866
	Non-IB	22.275	.578	21.130	23.419
5. Achievement Motivation	IB	16.918	.540	15.849	17.988
	Non-IB	15.745	.590	14.575	16.915
6. Achievement Approach	IB	19.213	.619	17.987	20.439
	Non-IB	18.843	.676	17.503	20.184

Profile plots

Below are the plots of the estimated means. An alternating trend is apparent across the 3 sets of factors. The non-IB average score is higher on the surface levels, while the IB graduates score higher on the achievement levels.

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Estimated Marginal Means
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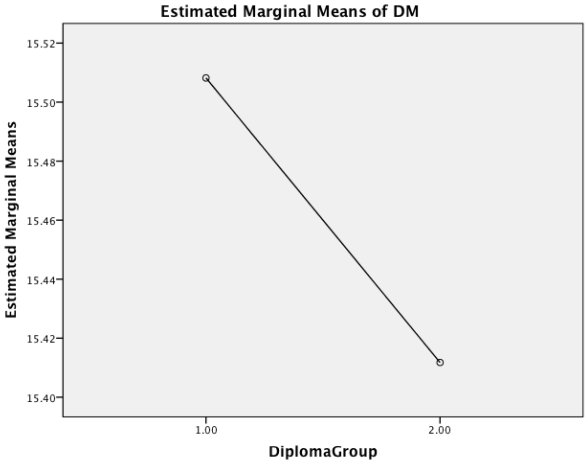
DiplomaGroup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2.00
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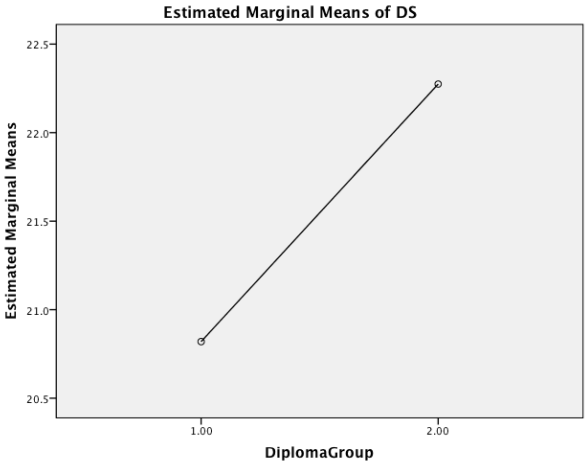
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Estimated Marginal Means
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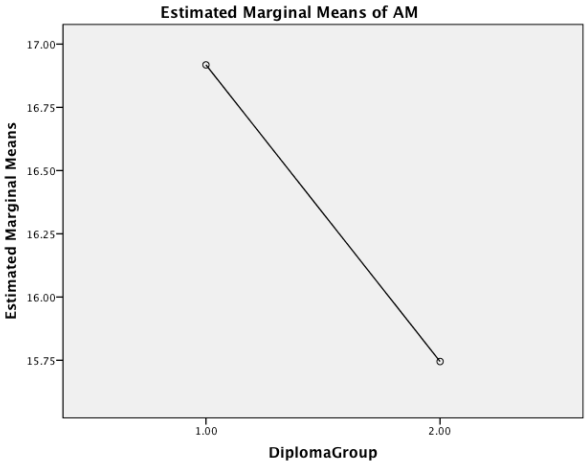
2.00
DiplomaGroup



VNOS-C ANOVA

Descriptive statistics

For the VNOS-C ANOVA, group 1 included 44 IB graduates and group 2 had 41 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the total score are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

		N
Diploma Group	IB	44
	Non-IB	41

The table below presents the means and standard deviations for each group.

Diploma Group	*Mean*	*Std. Deviation*	*N*
IB Graduates	235.36	14.77	44
Non-IB Graduates	236.34	16.30	41
Total	235.84	15.44	85

Test of assumptions

Levene's test of equality of error variances was not significant ($F(1, 83) = .033$, $p < .856$) meaning it is safe to assume homogeneity of variances in the data set.

Tests of between-subjects effects

ANOVA did not reveal a significant difference between groups ($F(1, 83) = .084$, $p < .772$, partial $\eta^2 = .001$). The ANOVA had weak power .059.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	20.293	1	20.293	.084	.772	.001
Error	20007.401	83	241.053			
Total	4747582.000	85				

Parameter estimates

Parameter	*B*	*Std. Error*	*t*	*Sig.*	*95% Confidence Interval*		*Partial Eta Squared*
					Lower Bound	Upper Bound	
Intercept	236.341	2.425	97.471	.000	231.519	241.164	.991
IB Graduates	-.978	3.370	-.290	.772	-7.681	5.725	.001

Parameter	*Observed Power*
Intercept	1.000
IB Graduates	.059

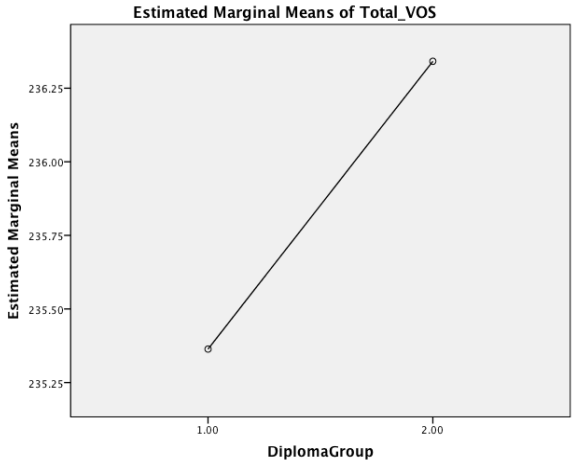
Estimated marginal means

The following table provides the estimates, along with standard deviations and confidence intervals.

Diploma Group	*Mean*	*Std. Error*	*95% Confidence Interval*	
			Lower Bound	Upper Bound
IB Graduates	235.36	2.34	230.708	240.019
Non-IB Graduates	236.34	2.43	231.519	241.164

Profile plots

Below is a plot of the estimated marginal mean, which graphically demonstrates the lower average score for the IB graduates compared to the non-IB graduates.



VNOS-C MANOVA

Descriptive statistics

For the MISEQ MANOVA, group 1 included 44 IB graduates and group 2 had 41 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the totals for each factor are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

The table below presents the means and standard deviations for each factor of the VNOS-C inventory for both groups.

	Diploma Group	*Mean*	*Std. Deviation*	*N*
Tentativeness	IB	8.52	1.56	44
	Non-IB	9.12	1.78	41
	Total	8.81	1.69	85
Nature & Observations	IB	16.48	2.70	44
	Non-IB	16.90	3.02	41
	Total	16.68	2.85	85
Scientific Method	IB	16.41	2.70	44
	Non-IB	16.61	3.54	41
	Total	16.51	3.11	85
Theories & Laws	IB	41.07	6.11	44
	Non-IB	40.20	6.56	41
	Total	40.65	6.31	85
Imagination	IB	17.73	4.05	44
	Non-IB	18.22	3.33	41

	Total	17.96	3.71	85
	IB	22.36	2.53	44
Validation	Non-IB	22.80	2.76	41
	Total	22.58	2.64	85
	IB	95.45	8.11	44
Subjectivity & Objectivity	Non-IB	97.41	8.79	41
	Total	96.40	8.45	85

Tests of Assumptions

Box's Test of Equality of Covariance Matrices was significant (M = 61.73, $F(28, 23748) = 2.006$, $p < .001$) suggesting that the assumption of the homogeneity of variances-covariances is not tenable.

The test of the equality of error variances were not significant suggesting that is safe to assume homogeneous variance in the data set.

	F	*df1*	*df2*	*Sig.*
Tentativeness	.639	1	83	.426
Nature & Observations	.466	1	83	.497
Scientific & Method	3.091	1	83	.082
Theories & Laws	.221	1	83	.640
Imagination	1.418	1	83	.237
Validation	.170	1	83	.682
Subjectivity & Objectivity	.053	1	83	.818

Multivariate Tests

The multivariate test did not reveal a significant difference between groups ($\Lambda = .950$, $F(7, 77) = .579$, $p < .771$, partial $\eta^2 = .050$). The MANOVA had weak power .234.

Effect		*Value*	*F*	*Hypothesis df*	*Error df*	*Sig.*	*Partial Eta Squared*
Diploma Group	Pillai's Trace	.050	.579b	7.000	77.000	.771	.050
	Wilks' Lambda	.950	.579b	7.000	77.000	.771	.050
	Hotelling's Trace	.053	.579b	7.000	77.000	.771	.050
	Roy's Largest Root	.053	.579b	7.000	77.000	.771	.050

Tests of between-subject effects

The table of between-subject effects below shows that none of the tests presented a significant difference between the two groups however all the effects are relatively small as can be noted in the Partial Eta Squared column of the following table. As can be seen in the same table, observed power for each factor was also very weak.

Source	*Dependent Variable*	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
Diploma Group	Tentativeness	7.621	1	7.621	2.734	.102
	Nature & Observations	3.837	1	3.837	.471	.495
	Scientific & Method	.855	1	.855	.087	.768
	Theories & Laws	16.177	1	16.177	.404	.527
	Imagination	5.142	1	5.142	.371	.544
	Validation	4.132	1	4.132	.591	.444
	Subjectivity & Objectivity	81.540	1	81.540	1.144	.288
Error	Tentativeness	231.368	83	2.788		
	Nature & Observations	676.587	83	8.152		
	Scientific & Method	812.392	83	9.788		
	Theories & Laws	3327.234	83	40.087		
	Imagination	1149.752	83	13.852		
	Validation	580.621	83	6.995		
	Subjectivity & Objectivity	5914.860	83	71.263		
Total	Tentativeness	6839.000	85			
	Nature & Observations	24336.000	85			
	Scientific & Method	23971.000	85			
	Theories & Laws	143779.000	85			
	Imagination	28587.000	85			
	Validation	43909.000	85			
	Subjectivity & Objectivity	795898.000	85			

Source	*Dependent Variable*	*Partial Eta Squared*	*Observed Power*
Diploma Group	Tentativeness	.032	.373
	Nature & Observations	.006	.104
	Scientific & Method	.001	.060
	Theories & Laws	.005	.096
	Imagination	.004	.092
	Validation	.007	.118
	Subjectivity & Objectivity	.014	.185

Parameter estimates

Dependent Variable	*Parameter*	*B*	*Std. Error*	*t*	*Sig.*	*95% Confidence Interval*
						Lower Bound
Tentativeness	Intercept	9.122	.261	34.984	.000	8.603
	IB Graduates	-.599	.362	-1.653	.102	-1.320
Nature & Observations	Intercept	16.902	.446	37.907	.000	16.016
	IB Graduates	-.425	.620	-.686	.495	-1.658
Scientific & Method	Intercept	16.610	.489	33.995	.000	15.638
	IB Graduates	-.201	.679	-.295	.768	-1.551
Theories & Laws	Intercept	40.195	.989	40.650	.000	38.228
	IB Graduates	.873	1.374	.635	.527	-1.860
Imagination	Intercept	18.220	.581	31.345	.000	17.063
	IB Graduates	-.492	.808	-.609	.544	-2.099
Validation	Intercept	22.805	.413	55.209	.000	21.983
	IB Graduates	-.441	.574	-.769	.444	-1.583
Subjectivity & Objectivity	Intercept	97.415	1.318	73.890	.000	94.792
	IB Graduates	-1.960	1.832	-1.070	.288	-5.605

Dependent Variable	*Parameter*	*95% Confidence Interval*	*Partial Eta Squared*	*Observed Power*
		Upper Bound		
Tentativeness	Intercept	9.641	.936	1.000
	IB Graduates	.122	.032	.373
Nature & Observations	Intercept	17.789	.945	1.000
	IB Graduates	.807	.006	.104
Scientific & Method	Intercept	17.582	.933	1.000
	IB Graduates	1.150	.001	.060
	[Diploma Group=2.00]	.a	.	.
Theories & Laws	Intercept	42.162	.952	1.000
	IB Graduates	3.607	.005	.096
	[Diploma Group=2.00]	.a	.	.
Imagination	Intercept	19.376	.922	1.000
	IB Graduates	1.115	.004	.092
Validation	Intercept	23.626	.973	1.000
	IB Graduates	.701	.007	.118
Subjectivity & Objectivity	Intercept	100.037	.985	1.000
	IB Graduates	1.685	.014	.185

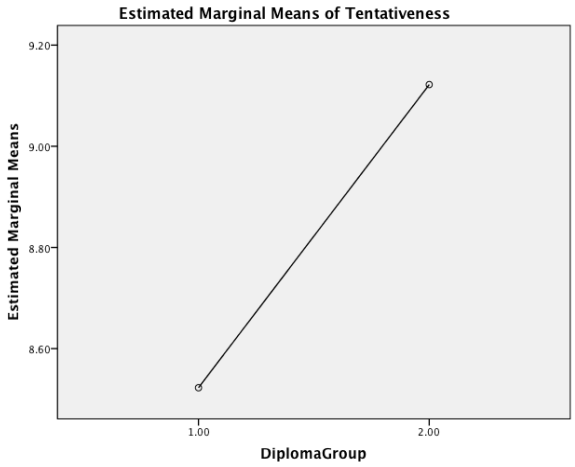
Estimated marginal means

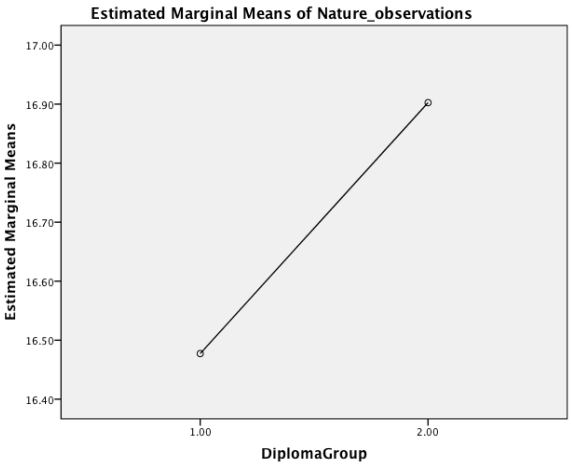
Following is a table with the means, along with standard deviations and confidence intervals.

Dependent Variable	*Diploma Group*	*Mean*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	Upper Bound
Tentativeness	IB Graduates	8.52	.25	8.022	9.023
	Non-IB Graduates	9.12	.26	8.603	9.641
Nature & Observations	IB Graduates	16.48	.43	15.621	17.333
	Non-IB Graduates	16.90	.45	16.016	17.789
Scientific & Method	IB Graduates	16.41	.47	15.471	17.347
	Non-IB Graduates	16.61	.49	15.638	17.582
Theories & Laws	IB Graduates	41.07	.96	39.170	42.967
	Non-IB Graduates	40.20	.99	38.228	42.162
Imagination	IB Graduates	17.73	.56	16.611	18.843
	Non-IB Graduates	18.22	.58	17.063	19.376
Validation	IB Graduates	22.36	.40	21.571	23.157
	Non-IB Graduates	22.81	.41	21.983	23.626
Subjectivity & Objectivity	IB Graduates	95.46	1.27	92.923	97.986
	Non-IB Graduates	97.46	1.32	94.792	100.037

Profile plots

Below are the plots of the estimated means. There is an alternating trend apparent across all 7 factors.

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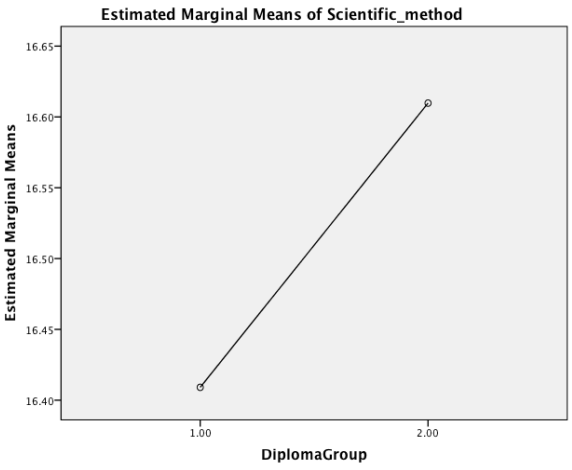
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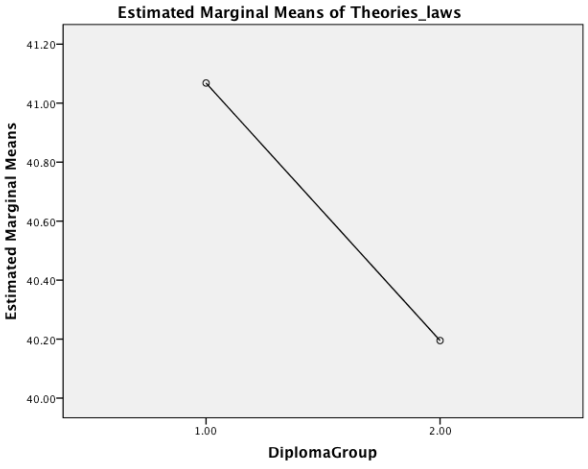
DiplomaGroup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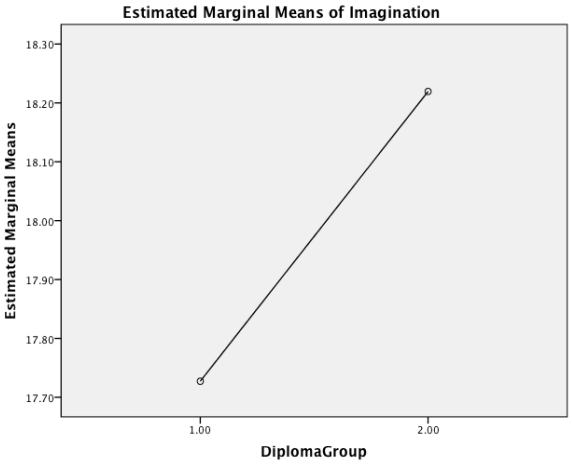
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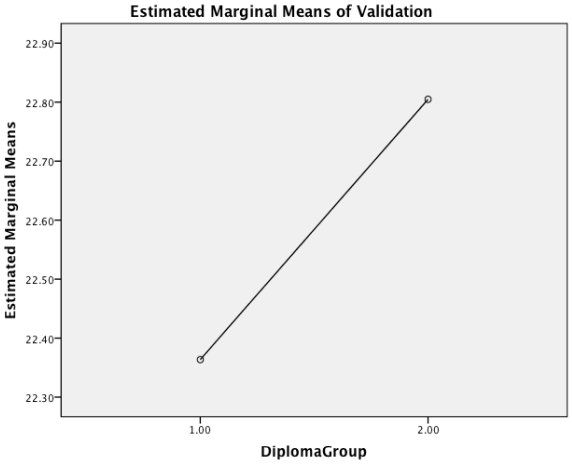
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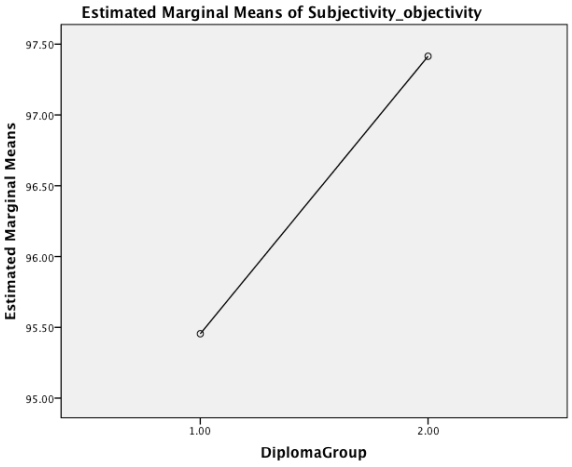
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Estimated Marginal Means
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DiplomaGroup

Appendices E

```
CORRELATIONS
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SDEIQ_Factor_04 SDEIQ_Factor_05
    SDEIQ_Factor_06 SDEIQ_Factor_07 SDEI_total
  /PRINT=TWOTAIL NOSIG
  /STATISTICS DESCRIPTIVES
  /MISSING=PAIRWISE.

CORRELATIONS
  /VARIABLES=MsDIQ_FS1 MsDIQ_FS2 MsDIQ_FS3 MsDIQ_FS4 MsDIQ_FS5
MsDIQ_FS6 MsDIQ_FSDS1 MsDIQ_FSDS2 MsDIQ_FSDS3 MsDIQ_FSDS4 MsDIQ_FSDS5
MsDIQ_FSDS6 MsDIQ_FSDSR1
  /PRINT=TWOTAIL NOSIG
  /MISSING=PAIRWISE.

UNIANOVA SDEI_total BY Diploma Group
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PLOT=PROFILE(Diploma Group)
  /EMMEANS=TABLES(Diploma Group)
  /PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /CRITERIA=ALPHA(.05)
  /DESIGN=Diploma Group.

GLM SDEIQ_Factor_01 SDEIQ_Factor_02 SDEIQ_Factor_03 SDEIQ_Factor_04
SDEIQ_Factor_05 SDEIQ_Factor_06
    SDEIQ_Factor_07 BY Diploma Group
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PLOT=PROFILE(Diploma Group)
  /EMMEANS=TABLES(Diploma Group)
  /PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /CRITERIA=ALPHA(.05)
  /DESIGN= Diploma Group.

UNIANOVA mSDIQ_Total BY Diploma Group
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PLOT=PROFILE(Diploma Group)
  /EMMEANS=TABLES(Diploma Group)
  /PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /CRITERIA=ALPHA(.05)
  /DESIGN=Diploma Group.
```

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GLM MsDIQ_Prep_FAC1 MsDIQ_Prep_FAC2 MsDIQ_Prep_FAC3 MsDIQ_Prep_FAC4
MsDIQ_Prep_FAC5 MsDIQ_Prep_FAC6
  MsDIQ_Prep_FAC7 MsDIQ_Integ_FAC1 MsDIQ_Integ_FAC2 MsDIQ_Integ_FAC3
MsDIQ_Integ_FAC4
  MsDIQ_Integ_FAC5 MsDIQ_Integ_FAC6 MsDIQ_Reflect_FAC1 BY Diploma Group
 /METHOD=SSTYPE(3)
 /INTERCEPT=INCLUDE
 /PLOT=PROFILE(Diploma Group)
 /EMMEANS=TABLES(Diploma Group)
 /PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
 /CRITERIA=ALPHA(.05)
 /DESIGN= Diploma Group.
```

Appendix F

SDEIQ Bivariate Correlations

		SDEIQ_Factor_01	*SDEIQ_Factor_02*	*SDEIQ_Factor_03*	*SDEIQ_Factor_04*	*SDEIQ_Factor_05*
SDEIQ_Factor_01	Pearson Correlation	1	.709**	.792**	.733**	.689**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	177	169	171	175	171
SDEIQ_Factor_02	Pearson Correlation	.709**	1	.698**	.681**	.556**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	169	177	170	175	168
SDEIQ_Factor_03	Pearson Correlation	.792**	.698**	1	.752**	.617**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	171	170	178	176	168
SDEIQ_Factor_04	Pearson Correlation	.733**	.681**	.752**	1	.632**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	175	175	176	185	173
SDEIQ_Factor_05	Pearson Correlation	.689**	.556**	.617**	.632**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	171	168	168	173	174
SDEIQ_Factor_06	Pearson Correlation	.598**	.462**	.601**	.575**	.572**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	176	175	177	183	173
SDEIQ_Factor_07	Pearson Correlation	.772**	.739**	.715**	.713**	.746**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	174	174	176	181	171
SDEI_total	Pearson Correlation	.918**	.851**	.896**	.866**	.791**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	155	155	155	155	155

		SDEIQ_Factor_06	*SDEIQ_Factor_07*	*SDEI_total*
SDEIQ_Factor_01	Pearson Correlation	.598	.772**	.918**
	Sig. (2-tailed)	.000	.000	.000
	N	176	174	155

SDEIQ_Factor_02	Pearson Correlation	.462**	.739	.851**
	Sig. (2-tailed)	.000	.000	.000
	N	175	174	155
SDEIQ_Factor_03	Pearson Correlation	.601**	.715**	.896
	Sig. (2-tailed)	.000	.000	.000
	N	177	176	155
SDEIQ_Factor_04	Pearson Correlation	.575**	.713**	.866**
	Sig. (2-tailed)	.000	.000	.000
	N	183	181	155
SDEIQ_Factor_05	Pearson Correlation	.572**	.746**	.791**
	Sig. (2-tailed)	.000	.000	.000
	N	173	171	155
SDEIQ_Factor_06	Pearson Correlation	1**	.584**	.698**
	Sig. (2-tailed)		.000	.000
	N	185	182	155
SDEIQ_Factor_07	Pearson Correlation	.584**	1**	.900**
	Sig. (2-tailed)	.000		.000
	N	182	185	155
SDEI_total	Pearson Correlation	.698**	.900**	1**
	Sig. (2-tailed)	.000	.000	
	N	155	155	155

MsDIQ Bivariate Correlations

		MsDIQ_FS1	*MsDIQ_FS2*	*MsDIQ_FS3*	*MsDIQ_FS4*	*MsDIQ_FS5*
MsDIQ_FS1	Pearson Correlation	1	.520**	.594**	.723**	.648**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FS2	Pearson Correlation	.520**	1	.484**	.683**	.541**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FS3	Pearson Correlation	.594**	.484**	1	.657**	.592**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	49	49	49	49	49
MsDIQ_FS4	Pearson Correlation	.723**	.683**	.657**	1	.601**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	49	49	49	49	49
MsDIQ_FS5	Pearson Correlation	.648**	.541**	.592**	.601**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	49	49	49	49	49

MsDIQ_FS6	Pearson Correlation	.217	.201	.445**	.168	.406**
	Sig. (2-tailed)	.135	.166	.001	.250	.004
	N	49	49	49	49	49
MsDIQ_FSDS1	Pearson Correlation	.563**	.500**	.670**	.528**	.491**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FSDS2	Pearson Correlation	.603**	.639**	.668**	.605**	.669**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FSDS3	Pearson Correlation	.670**	.577**	.619**	.540**	.569**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FSDS4	Pearson Correlation	.794**	.605**	.617**	.766**	.575**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FSDS5	Pearson Correlation	.558**	.685**	.670**	.614**	.710**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FSDS6	Pearson Correlation	.408**	.519**	.376**	.418**	.411**
	Sig. (2-tailed)	.004	.000	.008	.003	.003
	N	49	49	49	49	49
MsDIQ_FSDSR1	Pearson Correlation	.712**	.634**	.639**	.616**	.738**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	49	49	49	49	49

		MsDIQ_FS6	*MsDIQ_FSDS1*	*MsDIQ_FSDS2*	*MsDIQ_FSDS3*	*MsDIQ_FSDS4*
MsDIQ_FS1	Pearson Correlation	.217	.563**	.603**	.670**	.794**
	Sig. (2-tailed)	.135	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FS2	Pearson Correlation	.201**	.500	.639**	.577**	.605**
	Sig. (2-tailed)	.166	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FS3	Pearson Correlation	.445**	.670**	.668	.619**	.617**

	Sig. (2-tailed)	.001	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FS4	Pearson Correlation	.168**	.528**	.605**	.540	.766**
	Sig. (2-tailed)	.250	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FS5	Pearson Correlation	.406**	.491**	.669**	.569**	.575
	Sig. (2-tailed)	.004	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FS6	Pearson Correlation	1	.225	.324**	.271	.214**
	Sig. (2-tailed)		.119	.023	.059	.140
	N	49	49	49	49	49
MsDIQ_FSDS1	Pearson Correlation	.225**	1**	.709**	.783**	.734**
	Sig. (2-tailed)	.119		.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FSDS2	Pearson Correlation	.324**	.709**	1**	.813**	.743**
	Sig. (2-tailed)	.023	.000		.000	.000
	N	49	49	49	49	49
MsDIQ_FSDS3	Pearson Correlation	.271**	.783**	.813**	1**	.765**
	Sig. (2-tailed)	.059	.000	.000		.000
	N	49	49	49	49	49
MsDIQ_FSDS4	Pearson Correlation	.214**	.734**	.743**	.765**	1**
	Sig. (2-tailed)	.140	.000	.000	.000	
	N	49	49	49	49	49
MsDIQ_FSDS5	Pearson Correlation	.377**	.633**	.719**	.776**	.640**
	Sig. (2-tailed)	.008	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FSDS6	Pearson Correlation	.096**	.570**	.735**	.616**	.552**
	Sig. (2-tailed)	.511	.000	.000	.000	.000
	N	49	49	49	49	49
MsDIQ_FSDSR1	Pearson Correlation	.356**	.685**	.696**	.707**	.754**
	Sig. (2-tailed)	.012	.000	.000	.000	.000
	N	49	49	49	49	49

		MsDIQ_FSDS5	*MsDIQ_FSDS6*	*MsDIQ_FSDSR1*
MsDIQ_FS1	Pearson Correlation	.558	.408**	.712**

	Sig. (2-tailed)	.000	.004	.000
	N	49	49	49
	Pearson Correlation	.685**	.519	.634**
MsDIQ_FS2	Sig. (2-tailed)	.000	.000	.000
	N	49	49	49
	Pearson Correlation	.670**	.376**	.639
MsDIQ_FS3	Sig. (2-tailed)	.000	.008	.000
	N	49	49	49
	Pearson Correlation	.614**	.418**	.616**
MsDIQ_FS4	Sig. (2-tailed)	.000	.003	.000
	N	49	49	49
	Pearson Correlation	.710**	.411**	.738**
MsDIQ_FS5	Sig. (2-tailed)	.000	.003	.000
	N	49	49	49
	Pearson Correlation	.377	.096	.356**
MsDIQ_FS6	Sig. (2-tailed)	.008	.511	.012
	N	49	49	49
	Pearson Correlation	.633**	.570**	.685**
MsDIQ_FSDS1	Sig. (2-tailed)	.000	.000	.000
	N	49	49	49
	Pearson Correlation	.719**	.735**	.696**
MsDIQ_FSDS2	Sig. (2-tailed)	.000	.000	.000
	N	49	49	49
	Pearson Correlation	.776**	.616**	.707**
MsDIQ_FSDS3	Sig. (2-tailed)	.000	.000	.000
	N	49	49	49
	Pearson Correlation	.640**	.552**	.754**
MsDIQ_FSDS4	Sig. (2-tailed)	.000	.000	.000
	N	49	49	49
	Pearson Correlation	1**	.516**	.683**
MsDIQ_FSDS5	Sig. (2-tailed)		.000	.000
	N	49	49	49
	Pearson Correlation	.516**	1**	.399**
MsDIQ_FSDS6	Sig. (2-tailed)	.000		.004
	N	49	49	49
	Pearson Correlation	.683**	.399**	1**
MsDIQ_FSDSR1	Sig. (2-tailed)	.000	.004	
	N	49	49	49

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix G

SPSS Syntax

```
CORRELATIONS
  /VARIABLES=SEBQ_SeekSingleAnswers SEBQ_AvoidIntegration
SEBQ_AvoidAmbiguity
   SEBQ_KnowledgeCertain SEBQ_DependAuthority SEBQ_DontCriticizeAuthority
SEBQ_AbilityLearn
   SEBQ_CantLearnHowtoLearn SEBQ_SuccessNotHardWork SEBQ_LearnFirstTime
SEBQ_LearnQuick
   SEBQ_ConcentratedEffort SEBQ_TotalScore
  /PRINT=TWOTAIL NOSIG
  /STATISTICS DESCRIPTIVES
  /MISSING=PAIRWISE.

CORRELATIONS
  /VARIABLES=SM SS DM DS AM AS LPQ_Score
  /PRINT=TWOTAIL NOSIG
  /STATISTICS DESCRIPTIVES
  /MISSING=PAIRWISE.

UNIANOVA SEBQ_TotalScore BY Diploma Group
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PLOT=PROFILE(Diploma Group)
  /EMMEANS=TABLES(Diploma Group)
  /PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /CRITERIA=ALPHA(.05)
  /DESIGN=Diploma Group.

GLM SEBQ_SeekSingleAnswers SEBQ_AvoidIntegration SEBQ_AvoidAmbiguity
SEBQ_KnowledgeCertain
   SEBQ_DependAuthority SEBQ_DontCriticizeAuthority SEBQ_AbilityLearn
SEBQ_CantLearnHowtoLearn
   SEBQ_SuccessNotHardWork SEBQ_LearnFirstTime SEBQ_LearnQuick
SEBQ_ConcentratedEffort BY
   Diploma Group
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /EMMEANS=TABLES(Diploma Group)
  /PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /PRINT=ETASQ OPOWER
  /CRITERIA=ALPHA(.05)
  /DESIGN= Diploma Group.
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UNIANOVA LPQ_Score BY Diploma Group
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PLOT=PROFILE(Diploma Group)
  /EMMEANS=TABLES(Diploma Group)
  /PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /CRITERIA=ALPHA(.05)
  /DESIGN=Diploma Group.

GLM SM SS DM DS AM AS BY Diploma Group
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PLOT=PROFILE(Diploma Group)
  /EMMEANS=TABLES(Diploma Group)
  /PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /CRITERIA=ALPHA(.05)
  /DESIGN= Diploma Group.

CORRELATIONS
  /VARIABLES=Total VOSE Tentativeness Nature & Observations Scientific Method
Theories & Laws
    Imagination Validation Subjectivity & Objectivity
  /PRINT=TWOTAIL NOSIG
  /STATISTICS DESCRIPTIVES
  /MISSING=PAIRWISE.

UNIANOVA Total VOSE BY Diploma Group
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PLOT=PROFILE(Diploma Group)
  /EMMEANS=TABLES(Diploma Group)
  /PRINT=OPOWER PARAMETER ETASQ HOMOGENEITY DESCRIPTIVE
  /CRITERIA=ALPHA(.05)
  /DESIGN=Diploma Group.

GLM Tentativeness Nature & Observations Scientific & Method Theories & Laws
Imagination Validation
    Subjectivity & Objectivity BY Diploma Group
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PLOT=PROFILE(Diploma Group)
  /EMMEANS=TABLES(Diploma Group)
  /PRINT=DESCRIPTIVE ETASQ OPOWER PARAMETER HOMOGENEITY
  /CRITERIA=ALPHA(.05)
  /DESIGN= Diploma Group.
```

SEBQ Bivariate Correlations

		1. Seek Single Answers	2. Avoid Integration *n*	3. Avoid Ambiguity	4. Knowledge is Certain
1. Seek Single Answers	Pearson Correlation	1	.558**	.573**	.326**
	Sig. (2-tailed)		.000	.000	.005
	N	73	72	73	72
2. Avoid Integration	Pearson Correlation	.558**	1	.533**	.275*
	Sig. (2-tailed)	.000		.000	.020
	N	72	72	72	71
3. Avoid Ambiguity	Pearson Correlation	.573**	.533**	1	.217
	Sig. (2-tailed)	.000	.000		.067
	N	73	72	73	72
4. Knowledge is Certain	Pearson Correlation	.326**	.275*	.217	1
	Sig. (2-tailed)	.005	.020	.067	
	N	72	71	72	72
5. Depend on Authority	Pearson Correlation	.365**	.422**	.428**	.165
	Sig. (2-tailed)	.002	.000	.000	.166
	N	73	72	73	72
6. Don't Criticize Authority	Pearson Correlation	.428**	.591**	.351**	.301*
	Sig. (2-tailed)	.000	.000	.002	.010
	N	73	72	73	72
7. Ability to Learn	Pearson Correlation	.345**	.248*	.297*	.229
	Sig. (2-tailed)	.003	.036	.011	.053
	N	73	72	73	72
8. Can't Learn How to Learn	Pearson Correlation	.185	.382**	.261*	.244*
	Sig. (2-tailed)	.116	.001	.026	.039
	N	73	72	73	72
9. Success Not Hard Work	Pearson Correlation	.367**	.577**	.402**	.402**
	Sig. (2-tailed)	.001	.000	.000	.000
	N	73	72	73	72
10. Learn First Time	Pearson Correlation	.306**	.386**	.309**	.178

	Sig. (2-tailed)	.009	.001	.008	.135
	N	73	72	73	72
11. Learn Quick	Pearson Correlation	.293*	.270*	.173	.228
	Sig. (2-tailed)	.012	.022	.143	.054
	N	73	72	73	72
12. Concentrated Effort	Pearson Correlation	.508**	.280*	.500**	.180
	Sig. (2-tailed)	.000	.017	.000	.129
	N	73	72	73	72
13. SEBQ Total Score	Pearson Correlation	.779**	.786**	.710**	.525**
	Sig. (2-tailed)	.000	.000	.000	.000

		5. Depend on Authority	6. Don't Criticize Authority	7. Ability to Learn	8. Can't Learn How to Learn
1. Seek Single Answers	Pearson Correlation	.365	.428**	.345**	.185**
	Sig. (2-tailed)	.002	.000	.003	.116
	N	73	73	73	73
2. Avoid Integration	Pearson Correlation	.422**	.591	.248**	.382*
	Sig. (2-tailed)	.000	.000	.036	.001
	N	72	72	72	72
3. Avoid Ambiguity	Pearson Correlation	.428**	.351**	.297	.261
	Sig. (2-tailed)	.000	.002	.011	.026
	N	73	73	73	73
4. Knowledge is Certain	Pearson Correlation	.165**	.301*	.229	.244
	Sig. (2-tailed)	.166	.010	.053	.039
	N	72	72	72	72
5. Depend on Authority	Pearson Correlation	1**	.428**	.320**	.178
	Sig. (2-tailed)		.000	.006	.132
	N	73	73	73	73
6. Don't Criticize Authority	Pearson Correlation	.428**	1**	.321**	.341*
	Sig. (2-tailed)	.000		.006	.003
	N	73	73	73	73
7. Ability to Learn	Pearson Correlation	.320**	.321*	1*	-.087
	Sig. (2-tailed)	.006	.006		.466
	N	73	73	73	73

8. Can't Learn How to Learn	Pearson Correlation	.178	.341**	-.087*	1*
	Sig. (2-tailed)	.132	.003	.466	
	N	73	73	73	73
9. Success Not Hard Work	Pearson Correlation	.267**	.457**	.197**	.518**
	Sig. (2-tailed)	.022	.000	.095	.000
	N	73	73	73	73
10. Learn First Time	Pearson Correlation	.219**	.273**	.219**	.323
	Sig. (2-tailed)	.062	.020	.063	.005
	N	73	73	73	73
11. Learn Quick	Pearson Correlation	.085*	.243*	.343	.049
	Sig. (2-tailed)	.477	.038	.003	.680
	N	73	73	73	73
12. Concentrated Effort	Pearson Correlation	.264**	.269*	.161**	.098
	Sig. (2-tailed)	.024	.021	.173	.410
	N	73	73	73	73
13. SEBQ Total Score	Pearson Correlation	.612**	.697**	.495**	.478**
	Sig. (2-tailed)	.000	.000	.000	.000

		9. Success Not Hard Work	10. Learn First Time	11. Learn Quick	12. Concentrated Effort
1. Seek Single Answers	Pearson Correlation	.367	.306**	.293**	.508**
	Sig. (2-tailed)	.001	.009	.012	.000
	N	73	73	73	73
2. Avoid Integration	Pearson Correlation	.577**	.386	.270**	.280*
	Sig. (2-tailed)	.000	.001	.022	.017
	N	72	72	72	72
3. Avoid Ambiguity	Pearson Correlation	.402**	.309**	.173	.500
	Sig. (2-tailed)	.000	.008	.143	.000
	N	73	73	73	73
4. Knowledge is Certain	Pearson Correlation	.402**	.178*	.228	.180
	Sig. (2-tailed)	.000	.135	.054	.129
	N	72	72	72	72
5. Depend on Authority	Pearson Correlation	.267**	.219**	.085**	.264

	Sig. (2-tailed)	.022	.062	.477	.024
	N	73	73	73	73
6. Don't Criticize Authority	Pearson Correlation	.457**	.273**	.243**	.269*
	Sig. (2-tailed)	.000	.020	.038	.021
	N	73	73	73	73
7. Ability to Learn	Pearson Correlation	.197**	.219*	.343*	.161
	Sig. (2-tailed)	.095	.063	.003	.173
	N	73	73	73	73
8. Can't Learn How to Learn	Pearson Correlation	.518	.323**	.049*	.098*
	Sig. (2-tailed)	.000	.005	.680	.410
	N	73	73	73	73
9. Success Not Hard Work	Pearson Correlation	1**	.295**	.246**	.130**
	Sig. (2-tailed)		.011	.036	.271
	N	73	73	73	73
10. Learn First Time	Pearson Correlation	.295**	1**	.109**	.222
	Sig. (2-tailed)	.011		.361	.059
	N	73	73	73	73
11. Learn Quick	Pearson Correlation	.246*	.109*	1	.036
	Sig. (2-tailed)	.036	.361		.759
	N	73	73	73	73
12. Concentrated Effort	Pearson Correlation	.130**	.222*	.036**	1
	Sig. (2-tailed)	.271	.059	.759	
	N	73	73	73	73
13. SEBQ Total Score	Pearson Correlation	.680**	.521**	.408**	.498**
	Sig. (2-tailed)	.000	.000	.000	.000

		13. SEBQ Total Score
	Pearson Correlation	.779
1. Seek Single Answers	Sig. (2-tailed)	.000
	N	71
	Pearson Correlation	.786**
2. Avoid Integration	Sig. (2-tailed)	.000
	N	71
	Pearson Correlation	.710**
3. Avoid Ambiguity	Sig. (2-tailed)	.000
	N	71
4. Knowledge is Certain	Pearson Correlation	.525**

	Sig. (2-tailed)	.000
	N	71
	Pearson Correlation	.612**
5. Depend on Authority	Sig. (2-tailed)	.000
	N	71
	Pearson Correlation	.697**
6. Don't Criticize Authority	Sig. (2-tailed)	.000
	N	71
	Pearson Correlation	.495**
7. Ability to Learn	Sig. (2-tailed)	.000
	N	71
	Pearson Correlation	.478
8. Can't Learn How to Learn	Sig. (2-tailed)	.000
	N	71
	Pearson Correlation	.680**
9. Success Not Hard Work	Sig. (2-tailed)	.000
	N	71
	Pearson Correlation	.521**
10. Learn First Time	Sig. (2-tailed)	.000
	N	71
	Pearson Correlation	.408*
11. Learn Quick	Sig. (2-tailed)	.000
	N	71
	Pearson Correlation	.498**
12. Concentrated Effort	Sig. (2-tailed)	.000
	N	71
13. SEBQ Total Score	Pearson Correlation	1**
	Sig. (2-tailed)	

	1. Seek Single Answers	2. Avoid Integration *n*	3. Avoid Ambiguity	4. Knowledge is Certain
13. SEBQ Total Score N	71	71**	71**	71**

	5. Depend on Authority	6. Don't Criticize Authority	7. Ability to Learn	8. Can't Learn How to Learn
13. SEBQ Total Score N	71	71**	71**	71**

	9. Success Not Hard Work	10. Learn First Time	11. Learn Quick	12. Concentrated Effort
13. SEBQ Total Score N	71	71**	71**	71**

		SEBQ Total Score
13. SEBQ Total Score	N	71

LPQ Bivariate Correlations

		1. Surface Motivation	2. Surface Approach	3. Deep Motivation	4. Deep Approach	5. Achievement Motivation	6. Achievement Approach	*7. LPQ Total Score*
1. Surface Motivation	Pearson Correlation	1	.046	.347**	.489**	-.145	.073	.541**
	Sig. (2-tailed)		.726	.006	.000	.266	.575	.000
	N	61	61	61	61	61	61	61
2. Surface Approach	Pearson Correlation	.046	1	.156	-.158	.654**	.294*	.613**
	Sig. (2-tailed)	.726		.226	.220	.000	.020	.000
	N	61	62	62	62	62	62	61
3. Deep Motivation	Pearson Correlation	.347**	.156	1	.126	.169	.190	.631**
	Sig. (2-tailed)	.006	.226		.329	.188	.140	.000
	N	61	62	62	62	62	62	61
4. Deep Approach	Pearson Correlation	.489**	-.158	.126	1	-.305*	-.231	.260*
	Sig. (2-tailed)	.000	.220	.329		.016	.070	.043
	N	61	62	62	62	62	62	61
5. Achievement Motivation	Pearson Correlation	-.145	.654**	.169	-.305*	1	.517**	.585**
	Sig. (2-tailed)	.266	.000	.188	.016		.000	.000
	N	61	62	62	62	62	62	61
6. Achievement Approach	Pearson Correlation	.073	.294*	.190	-.231	.517**	1	.594**
	Sig. (2-tailed)	.575	.020	.140	.070	.000		.000
	N	61	62	62	62	62	62	61
7. LPQ Total Score	Pearson Correlation	.541**	.613**	.631**	.260*	.585**	.594**	1
	Sig. (2-tailed)	.000	.000	.000	.043	.000	.000	
	N	61	61	61	61	61	61	61

VOSE Bivariate Correlations

		Total VOSE	*Tentativeness*	*Nature & Observations*	*Scientific Method*
Total VOSE	Pearson Correlation	1	.506**	.589**	.468**
	Sig. (2-tailed)		.001	.000	.002
	N	43	43	43	43
Tentativeness	Pearson Correlation	.506**	1	.415**	.161
	Sig. (2-tailed)	.001		.006	.301
	N	43	44	43	43
Nature & Observations	Pearson Correlation	.589**	.415**	1	.253
	Sig. (2-tailed)	.000	.006		.102
	N	43	43	43	43
Scientific Method	Pearson Correlation	.468**	.161	.253	1
	Sig. (2-tailed)	.002	.301	.102	
	N	43	43	43	43
Theories & Laws	Pearson Correlation	.429**	.366*	.118	.253
	Sig. (2-tailed)	.004	.016	.452	.101
	N	43	43	43	43
Imagination	Pearson Correlation	.621**	.261	.214	.002
	Sig. (2-tailed)	.000	.087	.168	.990
	N	43	44	43	43
Validation	Pearson Correlation	.180	.095	-.044	.124
	Sig. (2-tailed)	.248	.543	.781	.429
	N	43	43	43	43
Subjectivity & Objectivity	Pearson Correlation	.842**	.419**	.605**	.341*
	Sig. (2-tailed)	.000	.005	.000	.025
	N	43	43	43	43

		Theories & Laws	*Imagination*	*Validation*	*Subjectivity & Objectivity*
Total VOSE	Pearson Correlation	.429	.621**	.180**	.842**
	Sig. (2-tailed)	.004	.000	.248	.000
	N	43	43	43	43
Tentativeness	Pearson Correlation	.366**	.261	.095**	.419
	Sig. (2-tailed)	.016	.087	.543	.005
	N	43	44	43	43

Nature Observations	Pearson &Correlation	.118**	.214**	-.044	.605
	Sig. (2-tailed)	.452	.168	.781	.000
	N	43	43	43	43
Scientific Method	Pearson Correlation	.253**	.002	.124	.341
	Sig. (2-tailed)	.101	.990	.429	.025
	N	43	43	43	43
Theories & Laws	Pearson Correlation	1**	.126*	.013	.194
	Sig. (2-tailed)		.422	.935	.213
	N	43	43	43	43
Imagination	Pearson Correlation	.126**	1	-.010	.727
	Sig. (2-tailed)	.422		.951	.000
	N	43	44	43	43
Validation	Pearson Correlation	.013	-.010	1	.222
	Sig. (2-tailed)	.935	.951		.152
	N	43	43	43	43
Subjectivity Objectivity	Pearson &Correlation	.194**	.727**	.222**	1*
	Sig. (2-tailed)	.213	.000	.152	
	N	43	43	43	43

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix H

SDEIQ ANOVA

Descriptive statistics

For the SDEIQ ANOVA, group 1 included 122 IB graduates and group 2 had 33 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the total score are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Diploma Group	*Mean*	*Std. Deviation*	*N*
IB Graduates	7.80	1.06	122
Non-IB Graduates	7.81	1.16	33
Total	7.80	1.08	155

Test of assumptions

Levene's test of equality of error variances was non-significant ($F(1, 253) = .402$, $p < .527$) meaning it is safe to assume homogeneity of variances in the data set.

Between-subject effects

ANOVA did not reveal a significant difference between groups ($F(1, 155) = .003$, $p < .957$, partial $\eta^2 = .000$). The ANOVA had weak power .050.

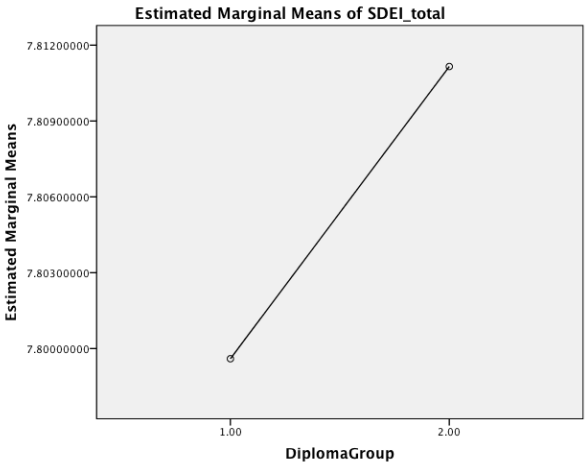
Estimated marginal means

The following table provides the actual estimates, along with standard deviations and confidence intervals.

Diploma Group	*Mean*	*Std. Error*	*95% Confidence Interval*	
			Lower Bound	Upper Bound
IB Graduates	7.80	.098	7.606	7.993
Non-IB Graduates	7.81	.189	7.439	8.184

Profile plots

Below is a plot of the estimated marginal means, which graphically demonstrates the lower average scores for the IB graduates compared to the non-IB graduates.



SDEIQ MANOVA

Descriptive statistics

For the SDEIQ MANOVA, group 1 included 122 IB graduates and group 2 had 33 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the totals for each factor are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Descriptive Statistics

	Diploma Group	Mean	Std. Deviation	N
1. Interpretation and presentation of results	IB Graduates	4.00	.60	122
	Non-IB Graduates	3.98	.61	33
	Total	4.00	.60	155
2. Domain general strategies	IB Graduates	3.68	.68	122
	Non-IB Graduates	3.78	.74	33
	Total	3.70	.69	155
3. Data analysis	IB Graduates	3.92	.61	122
	Non-IB Graduates	3.92	.60	33
	Total	3.92	.61	155
4. Self-regulatory strategies	IB Graduates	4.18	.51	122
	Non-IB Graduates	4.20	.68	33
	Total	4.18	.55	155
5. Classroom cooperation behaviors	IB Graduates	3.79	.61	122
	Non-IB Graduates	3.78	.78	33
	Total	3.79	.65	155

	IB Graduates	3.93	.76	122
6. Inquiry dispositions	Non-IB Graduates	3.81	.61	33
	Total	3.91	.73	155
7. Inquiry small group collaboration behaviors	IB Graduates	3.81	.63	122
	Non-IB Graduates	3.82	.64	33
	Total	3.81	.63	155

Box's Test of Equality of Covariance Matricesa

Box's M	*50.601*
F	1.657
df1	28
df2	12261.873
Sig.	.016

Levene's Test of Equality of Error Variances

	F	*df1*	*df2*	*Sig.*
1. Interpretation and presentation of results	.001	1	153	.979
2. Domain general strategies	.826	1	153	.365
3. Data analysis	.000	1	153	.986
4. Self-regulatory strategies	2.24	1	153	.136
5. Classroom cooperation behaviors	2.31	1	153	.130
6. Inquiry dispositions	2.82	1	153	.095
7. Inquiry small group collaboration behaviors	.056	1	153	.814

Multivariate test

The multivariate test did not reveal a significant difference between groups (Λ = .981, *F*7, 153) = .409, p < .895, partial η^2 = .019). The MANOVA had weak power .177.

Between-subject effects

The table of between-subject effects below shows that none of the tests revealed a significant difference between the two groups.

Source	*Dependent Variable*	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	1. Interpretation and presentation of results	.013	1	.013	.037	.849	.000
	2. Domain general strategies	.273	1	.273	.574	.450	.004
	3. Data analysis	.001	1	.001	.003	.954	.000
	4. Self-regulatory strategies	.010	1	.010	.032	.858	.000
	5. Classroom cooperation behaviors	.002	1	.002	.004	.947	.000
	6. Inquiry dispositions	.365	1	.365	.685	.409	.004
	7. Inquiry small group collaboration behaviors	.004	1	.004	.011	.917	.000
Error	1. Interpretation and presentation of results	54.880	153	.359			
	2. Domain general strategies	72.874	153	.476			
	3. Data analysis	56.563	153	.370			
	4. Self-regulatory strategies	46.292	153	.303			
	5. Classroom cooperation behaviors	64.870	153	.424			
	6. Inquiry dispositions	81.584	153	.533			
	7. Inquiry small group collaboration behaviors	60.933	153	.398			
Total	1. Interpretation and presentation of results	2529.358	155				
	2. Domain general strategies	2196.023	155				
	3. Data analysis	2435.079	155				

	4. Self-regulatory strategies	2758.705	155
	5. Classroom cooperation behaviors	2288.980	155
	6. Inquiry dispositions	2447.306	155
	7. Inquiry small group collaboration behaviors	2308.647	155

As can be seen in the table below, observed power for each factor were relatively weak.

Source	*Dependent Variable*	*Observed Power*
Diploma Group	1. Interpretation and presentation of results	.054
	2. Domain general strategies	.117
	3. Data analysis	.050
	4. Self-regulatory strategies	.054
	5. Classroom cooperation behaviors	.050
	6. Inquiry dispositions	.130
	7. Inquiry small group collaboration behaviors	.051

Estimated marginal means

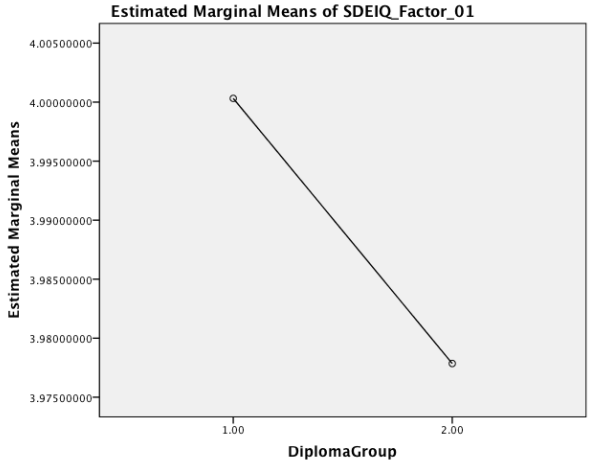
Following is a table with the means, along with standard deviations and confidence intervals.

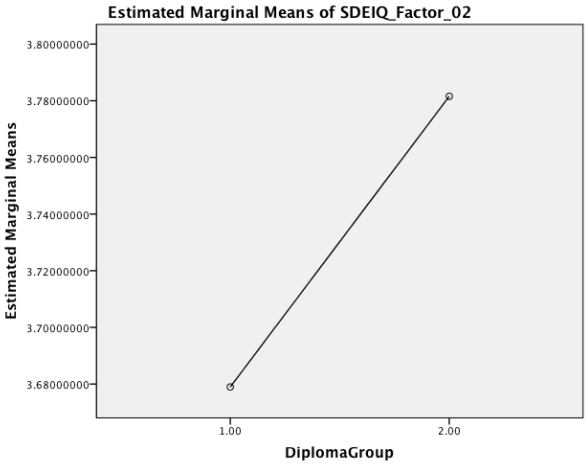
Dependent Variable	*Diploma Group*	*Mean*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	Upper Bound
1. Interpretation and presentation of results	IB Graduates	4.00	.054	3.893	4.107
	Non-IB Graduates	3.98	.104	3.772	4.184
2. Domain general	IB Graduates	3.68	.062	3.556	3.802

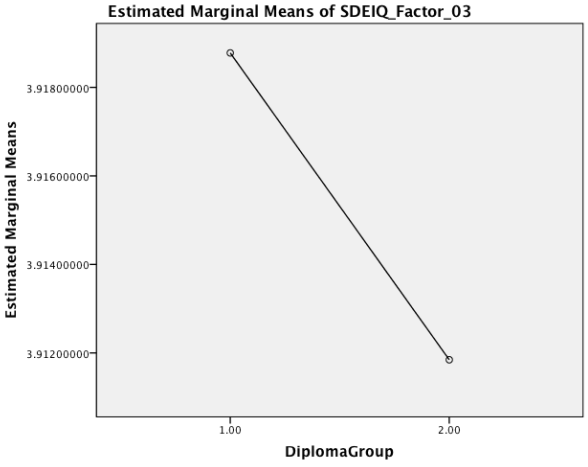
strategies	Non-IB Graduates	3.78	.120	3.544	4.019
	IB Graduates	3.92	.055	3.810	4.028
3. Data analysis	Non-IB Graduates	3.91	.106	3.703	4.121
	IB Graduates	4.18	.050	4.081	4.277
4. Self-regulatory strategies	Non-IB Graduates	4.20	.096	4.009	4.388
5. Classroom cooperation behaviors	IB Graduates	3.80	.059	3.673	3.906
	Non-IB Graduates	3.78	.113	3.557	4.005
6. Inquiry dispositions	IB Graduates	3.93	.066	3.801	4.062
	Non-IB Graduates	3.81	.127	3.562	4.064
7. Inquiry small group collaboration behaviors	IB Graduates	3.81	.057	3.692	3.918
	Non-IB Graduates	3.82	.110	3.601	4.035

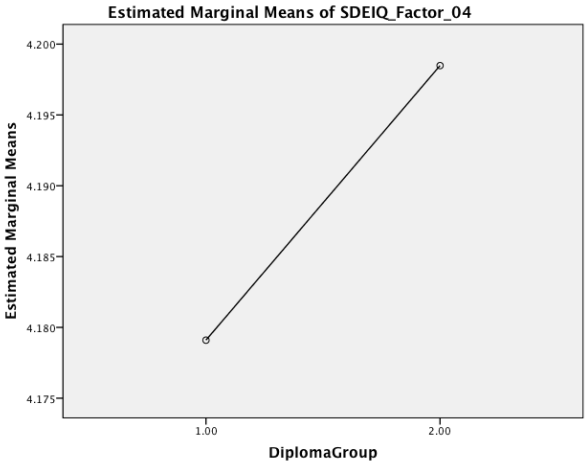
Profile plots

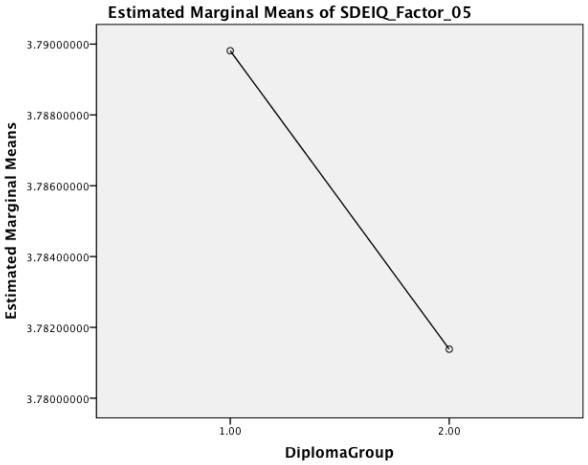
Below are the plots of the estimated marginal means, which present an alternating trend across all factors.

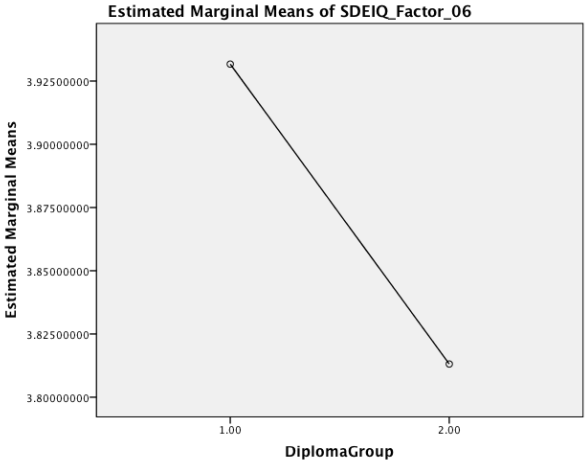


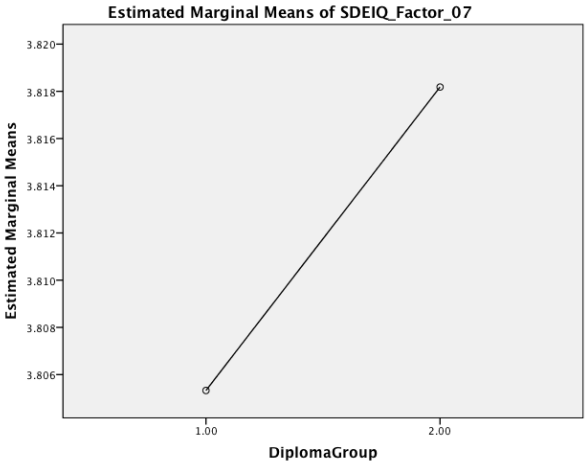

Estimated Marginal Means of SDEIQ_Factor_02
Estimated Marginal Means
3.80000000
3.78000000
3.76000000
3.74000000
3.72000000
3.70000000
3.68000000
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SDEIQ_Factor_03
Estimated Marginal Means
3.91800000
3.91600000
3.91400000
3.91200000
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SDEIQ_Factor_04
Estimated Marginal Means
4.200
4.195
4.190
4.185
4.180
4.175
1.00
2.00
DiplomaGroup







MSDIQ ANOVA

Descriptive statistics

For the MSDIQ ANOVA, group 1 included 40 IB graduates and group 2 had 11 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the total score are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Diploma Group	*Mean*	*Std. Deviation*	*N*
IB Graduates	7.85	1.06	40
Non-IB Graduates	7.50	.96	11
Total	7.78	1.04	51

Test of assumptions

Levene's test of equality of error variances was non-significant ($F(2, 49) = .068$, $p < .796$) meaning it is safe to assume homogeneity of variances in the data set.

Between-subject effects

ANOVA did not reveal a significant difference between groups ($F(1, 49) = .991$, $p < .324$, partial $\eta^2 = .020$). The ANOVA had weak power .164.

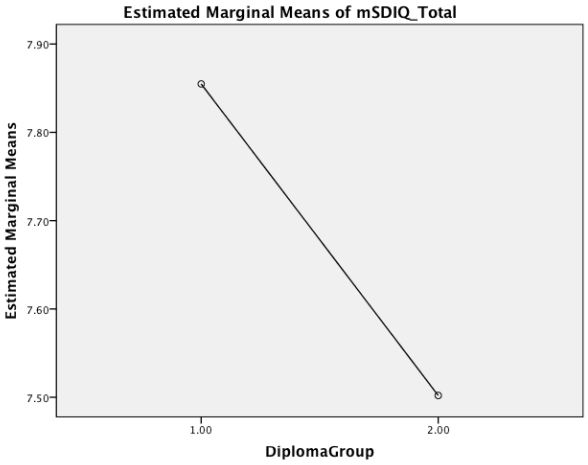
Estimated marginal means

Following is a table with the means, along with standard deviations and confidence intervals.

Diploma Group	*Mean*	*Std. Error*	*95% Confidence Interval*	
			Lower Bound	Upper Bound
1.00	7.86	.17	7.524	8.186
2.00	7.50	.31	6.871	8.133

Profile plots

Below is the plot of the estimated means, which graphically demonstrates the lower average score for the non-IB graduates.



MSDIQ MANOVA

Descriptive statistics

For the MSDIQ MANOVA, group 1 included 39 IB graduates and group 2 had 11 non-IB graduates.
The means and standard deviations for the IB and Non-IB diploma as well as the totals for each factor are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

	Diploma Group	*Mean*	*Std. Deviation*	*N*
1. Inquiry Comprehension	IB	8.60	1.53	39
	Non-IB	8.25	1.15	11
	Total	8.52	1.45	50
2. Generative Inquiry	IB	8.51	1.47	39
	Non-IB	7.86	1.02	11
	Total	8.37	1.40	50
3. Inquiry Planning	IB	7.38	1.72	39
	Non-IB	6.71	2.54	11
	Total	7.23	1.92	50
4. Problem Solving	IB	7.02	2.05	39
	Non-IB	6.36	1.95	11
	Total	6.88	2.03	50
5. Inquiry Teaching	IB	7.60	1.78	39
	Non-IB	6.78	1.65	11
	Total	7.42	1.77	50
6. Co-Construction of Inquiry	IB	7.55	1.81	39
	Non-IB	5.98	2.39	11
	Total	7.20	2.03	50
7. Student Data	IB	7.32	1.92	39

Organization Strategies	Non-IB	7.10	1.93	11
	Total	7.27	1.91	50
8. Student Inquiry Communication Strategies	IB	7.62	1.58	39
	Non-IB	7.11	1.77	11
	Total	7.51	1.62	50
9. Student Formal Reasoning Strategies	IB	8.18	1.55	39
	Non-IB	7.62	1.61	11
	Total	8.06	1.56	50
10. Student Data Interpretation Strategies	IB	7.85	1.88	39
	Non-IB	7.91	1.46	11
	Total	7.86	1.79	50
11. Student Self-Regulation Strategies for Inquiry Engagement	IB	7.76	1.90	39
	Non-IB	7.57	1.99	11
	Total	7.72	1.90	50
12. Student Search Strategies	IB	7.85	1.99	39
	Non-IB	7.71	2.18	11
	Total	7.82	2.01	50
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	IB	7.98	1.89	39
	Non-IB	7.19	1.44	11
	Total	7.81	1.82	50

Test of assumptions

Box's Test of Equality of Covariance Matrices was not calculated because the determinant of the covariance matrix was singular suggesting that the assumption of the homogeneity of variances-covariances has been violated.

The assumption of equality of variances was verified by the Levene's Test as can be seen below.

	F	*df1*	*df2*	*Sig.*
1. Inquiry Comprehension	.881	1	48	.353
2. Generative Inquiry	3.142	1	48	.083
3. Inquiry Planning	2.904	1	48	.095
4. Problem Solving	.106	1	48	.746
5. Inquiry Teaching	.010	1	48	.919
6. Co-Construction of Inquiry	1.012	1	48	.319

7. Student Data Organization Strategies	.186	1	48	.668
8. Student Inquiry Communication Strategies	.153	1	48	.697
9. Student Formal Reasoning Inquiry Strategies	.025	1	48	.875
10. Student Data Interpretation Strategies	.706	1	48	.405
11. Student Self-Regulation Strategies for Inquiry Engagement	.092	1	48	.763
12. Student Search Strategies	.413	1	48	.523
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	.273	1	48	.604

Multivariate test

The multivariate test did not reveal a significant difference between groups ($\Lambda = .740$, $F(13, 36) = .975$, $p < .493$, partial $\eta^2 = .260$). The MANOVA had moderate power .469.

Between-subject effects

The table of between-subject effects below shows that none of the factors except 6. Co-Construction of Inquiry present a significant difference between the two groups however all the effects are relatively small as can be noted in the Partial Eta Squared column. Further, powers are weak across all the factors. The only exception being 6. Co-Construction of Inquiry, which has the largest partial $\eta^2$and the most power at .637.

Source	*Dependent Variable*	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	1. Inquiry Comprehension	1.036	1	1.036	.489	.488	.010
	2. Generative Inquiry	3.685	1	3.685	1.912	.173	.038
	3. Inquiry Planning	3.918	1	3.918	1.059	.309	.022
	4. Problem Solving	3.783	1	3.783	.920	.342	.019
	5. Inquiry Teaching	5.758	1	5.758	1.865	.178	.037
	6. Co-Construction of Inquiry	21.025	1	21.025	5.565	.022	.104
	7. Student Data Organization Strategies	.400	1	.400	.108	.744	.002
	8. Student Inquiry Communication Strategies	2.291	1	2.291	.873	.355	.018

	9. Student Formal Reasoning Inquiry Strategies	2.679	1	2.679	1.099	.300	.022
	10. Student Data Interpretation Strategies	.024	1	.024	.007	.931	.000
	11. Student Self-Regulation Strategies for Inquiry Engagement	.305	1	.305	.083	.775	.002
	12. Student Search Strategies	.153	1	.153	.037	.848	.001
	13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	5.422	1	5.422	1.663	.203	.033
Error	1. Inquiry Comprehension	101.739	48	2.120			
	2. Generative Inquiry	92.493	48	1.927			
	3. Inquiry Planning	177.568	48	3.699			
	4. Problem Solving	197.389	48	4.112			
	5. Inquiry Teaching	148.209	48	3.088			

Source	*Dependent Variable*	*Observed Power*
Diploma Group	1. Inquiry Comprehension	.105
	2. Generative Inquiry	.273
	3. Inquiry Planning	.172
	4. Problem Solving	.156
	5. Inquiry Teaching	.268
	6. Co-Construction of Inquiry	.637
	7. Student Data Organization Strategies	.062
	8. Student Inquiry Communication Strategies	.150
	9. Student Formal Reasoning Inquiry Strategies	.177
	10. Student Data Interpretation Strategies	.051
	11. Student Self-Regulation Strategies for Inquiry Engagement	.059

	12. Student Search Strategies	.054
	13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	.244

Parameter Estimates

Dependent Variable	*Parameter*	*B*	*Std. Error*	*t*	*Sig.*	*95% Confidence Interval*	
						Lower Bound	Upper Bound
1. Inquiry Comprehension	Intercept	8.253	.439	18.801	.000	7.370	9.136
	IB Graduates	.347	.497	.699	.488	-.652	1.347
	Non-IB Graduates	0a	.	.	.	.	.
2. Generative Inquiry	Intercept	7.859	.419	18.778	.000	7.018	8.701
	IB Graduates	.655	.474	1.383	.173	-.297	1.608
	Non-IB Graduates	0a	.	.	.	.	.
3. Inquiry Planning	Intercept	6.707	.580	11.565	.000	5.541	7.873
	IB Graduates	.676	.657	1.029	.309	-.644	1.996
	Non-IB Graduates	0a	.	.	.	.	.
4. Problem Solving	Intercept	6.360	.611	10.403	.000	5.131	7.590
	IB Graduates	.664	.692	.959	.342	-.728	2.056
	Non-IB Graduates	0a	.	.	.	.	.
5. Inquiry Teaching	Intercept	6.784	.530	12.804	.000	5.718	7.849
	IB Graduates	.819	.600	1.366	.178	-.387	2.025
	Non-IB Graduates	0a	.	.	.	.	.
6. Co-Construction of Inquiry	Intercept	5.982	.586	10.208	.000	4.804	7.161
	IB Graduates	1.565	.664	2.359	.022	.231	2.900
	Non-IB Graduates	0a	.	.	.	.	.
7. Student Data Organization Strategies	Intercept	7.102	.580	12.248	.000	5.936	8.268
	IB Graduates	.216	.657	.329	.744	-1.104	1.536
	Non-IB Graduates	0a	.	.	.	.	.
8. Student Inquiry Communication Strategies	Intercept	7.105	.488	14.549	.000	6.123	8.087
	IB Graduates	.517	.553	.934	.355	-.595	1.629
	Non-IB Graduates	0a	.	.	.	.	.
9. Student Formal	Intercept	7.622	.471	16.192	.000	6.675	8.568
	IB Graduates	.559	.533	1.048	.300	-.513	1.630

Reasoning Strategies	Non-IB Graduates	0a	.	.	.	.	.
10. Student Data Interpretation Strategies	Intercept	7.906	.544	14.537	.000	6.813	9.000
	IB Graduates	-.053	.616	-.087	.931	-1.291	1.185
	Non-IB Graduates	0a	.	.	.	.	.
11. Student Self-Regulation Strategies for Inquiry Engagement	Intercept	7.571	.580	13.060	.000	6.405	8.737
	IB Graduates	.189	.656	.287	.775	-1.131	1.508
	Non-IB Graduates	0a	.	.	.	.	.
12. Student Search Strategies	Intercept	7.714	.612	12.615	.000	6.485	8.944
	IB Graduates	.134	.692	.193	.848	-1.259	1.526
	Non-IB Graduates	0a	.	.	.	.	.
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	Intercept	7.186	.545	13.197	.000	6.091	8.281
	IB Graduates	.795	.617	1.289	.203	-.445	2.035
	Non-IB Graduates	0a	.	.	.	.	.

Dependent Variable	*Parameter*	*Partial Eta Squared*	*Observed Power*
1. Inquiry Comprehension	Intercept	.880	1.000
	IB Graduates	.010	.105
	Non-IB Graduates	.a	.
2. Generative Inquiry	Intercept	.880	1.000
	IB Graduates	.038	.273
	Non-IB Graduates	.a	.
3. Inquiry Planning	Intercept	.736	1.000
	IB Graduates	.022	.172
	Non-IB Graduates	.a	.
4. Problem Solving	Intercept	.693	1.000
	IB Graduates	.019	.156
	Non-IB Graduates	.a	.
5. Inquiry Teaching	Intercept	.774	1.000
	IB Graduates	.037	.268
	Non-IB Graduates	.a	.
6. Co-Construction of Inquiry	Intercept	.685	1.000
	IB Graduates	.104	.637
	Non-IB Graduates	.a	.
7. Student Data Organization Strategies	Intercept	.758	1.000
	IB Graduates	.002	.062
	Non-IB Graduates	.a	.

8. Student Inquiry Communication Strategies	Intercept	.815	1.000
	IB Graduates	.018	.150
	Non-IB Graduates	.a	.
9. Student Formal Reasoning Strategies	Intercept	.845	1.000
	IB Graduates	.022	.177
	Non-IB Graduates	.a	.
10. Student Data Interpretation Strategies	Intercept	.815	1.000
	IB Graduates	.000	.051
	Non-IB Graduates	.a	.
11. Student Self-Regulation Strategies for Inquiry Engagement	Intercept	.780	1.000
	IB Graduates	.002	.059
	Non-IB Graduates	.a	.
12. Student Search Strategies	Intercept	.768	1.000
	IB Graduates	.001	.054
	Non-IB Graduates	.a	.
13. Student-Directed Strategies for Reflection on Inquiry Results and Experiences	Intercept	.784	1.000
	IB Graduates	.033	.244
	Non-IB Graduates	.a	.

Estimated marginal means

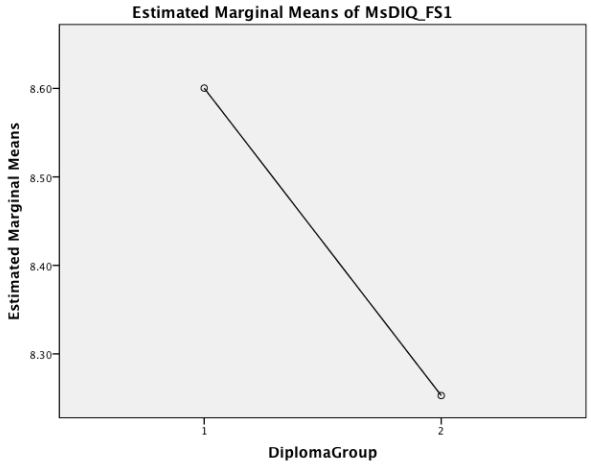
Following is a table with the means, along with standard deviations and confidence intervals.

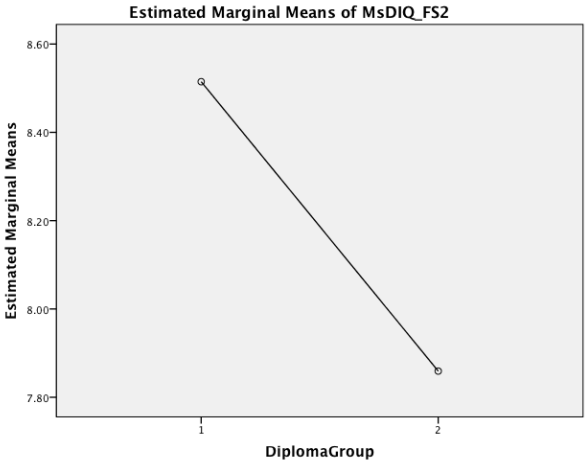
Dependent Variable	*Diploma Group*	*Mean*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	Upper Bound
1. Inquiry Comprehension	IB	8.60	.23	8.132	9.069
	Non-IB	8.25	.44	7.370	9.136
2. Generative Inquiry	IB	8.52	.22	8.068	8.962
	Non-IB	7.86	.42	7.018	8.701
3. Inquiry Planning	IB	7.38	.31	6.763	8.002
	Non-IB	6.71	.58	5.541	7.873
4. Problem Solving	IB	7.02	.36	6.372	7.677
	Non-IB	6.36	.61	5.131	7.590
5. Inquiry Teaching	IB	7.60	.28	7.037	8.169
	Non-IB	6.78	.53	5.718	7.849
6. Co-Construction of Inquiry	IB	7.55	.31	6.922	8.173
	Non-IB	5.98	.59	4.804	7.161
7. Student Data	IB	7.32	.31	6.699	7.938

Organization Strategies	Non-IB	7.10	.58	5.936	8.268
8. Student Inquiry	IB	7.62	.26	7.100	8.143
Communication Strategies	Non-IB	7.11	.49	6.123	8.087
9. Student Formal	IB	8.18	.25	7.678	8.683
Reasoning Inquiry Strategies	Non-IB	7.62	.47	6.675	8.568
10. Student Data	IB	7.85	.29	7.272	8.434
Interpretation Strategies	Non-IB	7.91	.54	6.813	9.000
11. Student Self-	IB	7.76	.31	7.141	8.379
Regulation Strategies for Inquiry Engagement	Non-IB	7.57	.58	6.405	8.737
12. Student Search	IB	7.85	.33	7.195	8.501
Strategies	Non-IB	7.71	.61	6.485	8.944
13. Student-Directed	IB	7.98	.29	7.399	8.562
Strategies for Reflection on Inquiry Results and Experiences	Non-IB	7.19	.55	6.091	8.281

Profile plots

Below are the plots of the estimated marginal means, which present the same trend across all factors except for Preparation 7 and Integration 4, which are reversed.




Estimated Marginal Means of MsDIQ_FS2
Estimated Marginal Means
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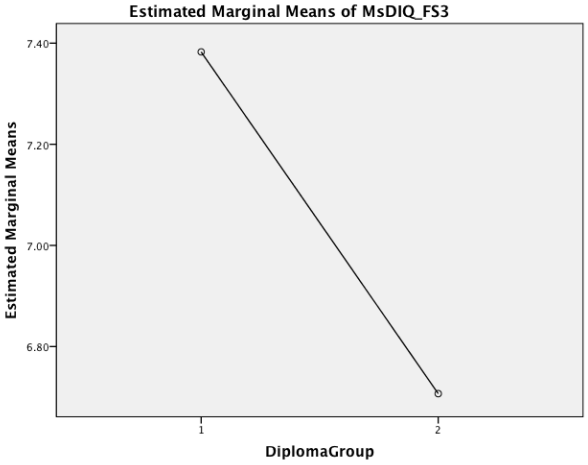
8.40
8.20
8.00
7.80
1
2
DiplomaGroup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Estimated Marginal Means
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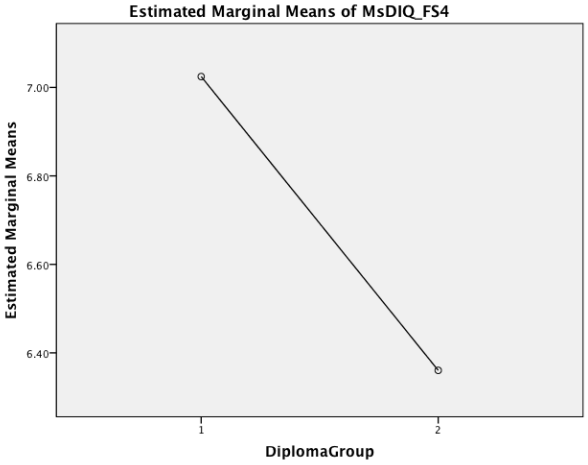
7.20
7.00
6.80
1
2
DiplomaGroup


Estimated Marginal Means of MsDIQ_FS4
Estimated Marginal Means
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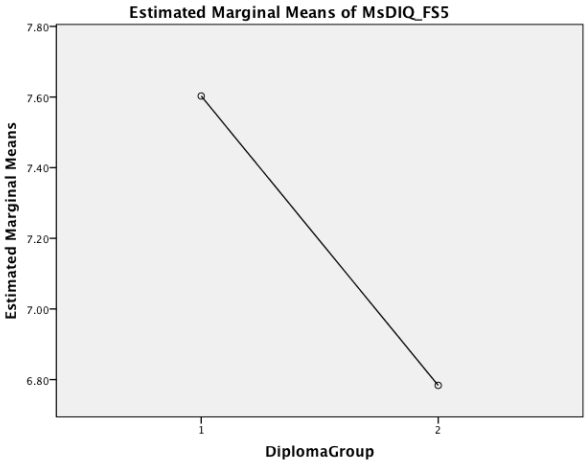
6.80
6.60
6.40
1
2
DiplomaGroup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Estimated Marginal Means
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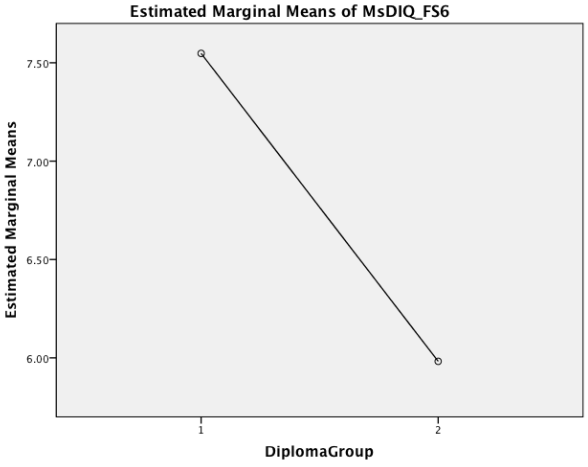
7.60
7.40
7.20
7.00
6.80
1
2
DiplomaGroup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Estimated Marginal Means
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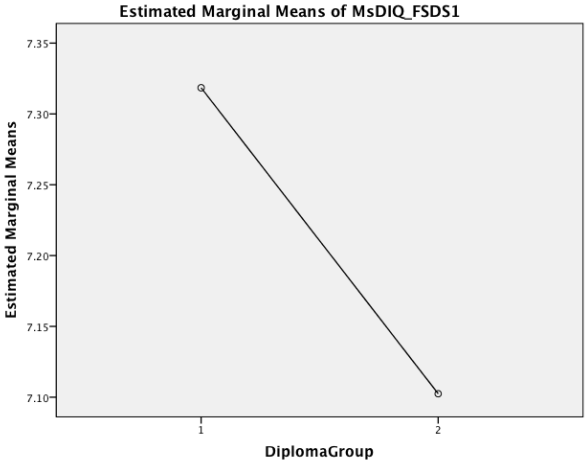
7.00
6.50
6.00
1
2
DiplomaGroup


Estimated Marginal Means of MsDIQ_FSDS1
Estimated Marginal Means
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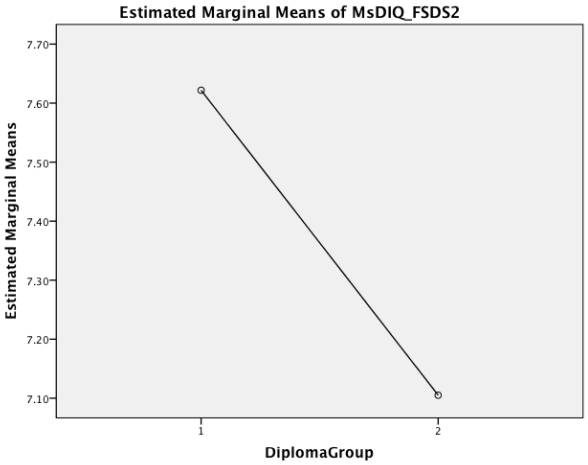
7.30
7.25
7.20
7.15
7.10
1
2
DiplomaGroup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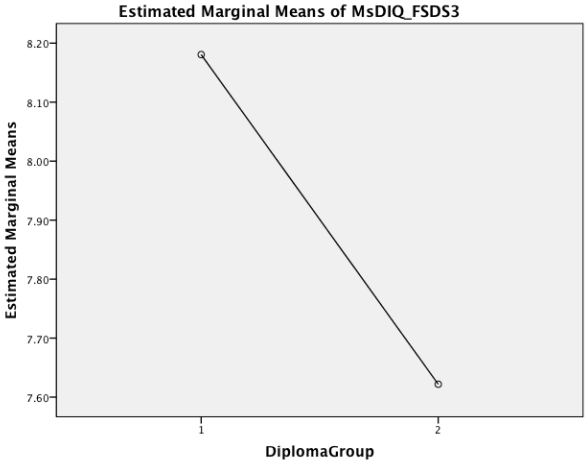
7.50
7.40
7.30
7.20
7.10
1
2
DiplomaGroup


Estimated Marginal Means of MsDIQ_FSDS3
Estimated Marginal Means
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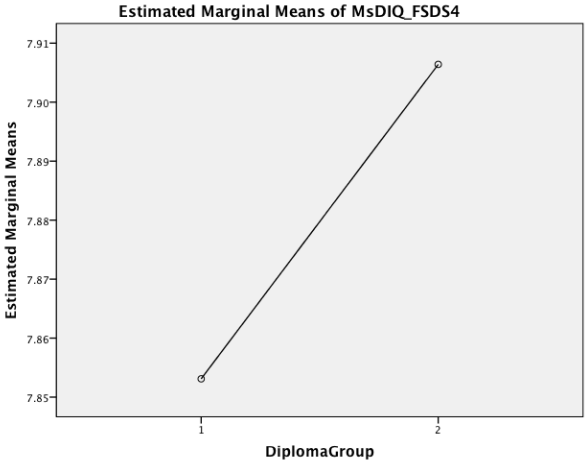
8.10
8.00
7.90
7.80
7.70
7.60
1
2
DiplomaGroup


Estimated Marginal Means of MsDIQ_FSDS4
Estimated Marginal Means
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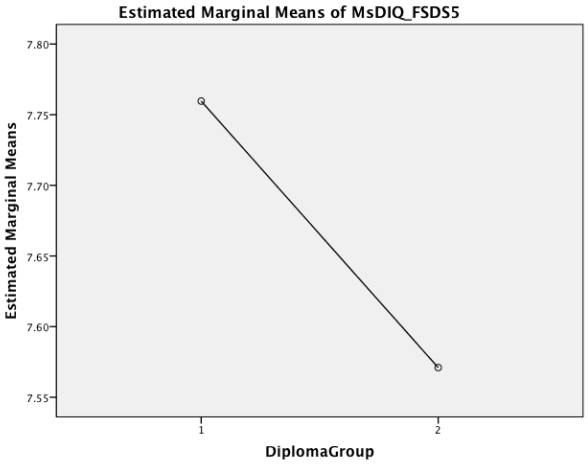
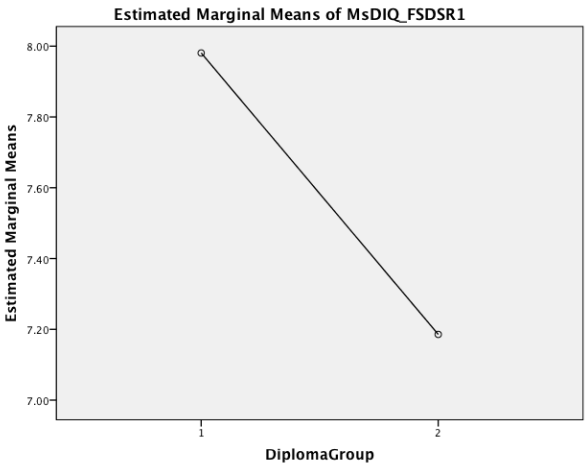
7.90
7.89
7.88
7.87
7.86
7.85
1
2
DiplomaGroup





SEBQ ANOVA

Descriptive statistics

For the SDEIQ ANOVA, group 1 included 55 IB graduates and group 2 had 16 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the total score are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Diploma Group	*Mean*	*Std. Deviation*	*N*
IB Graduates	2.98	.30	55
Non-IB Graduates	2.84	.34	16
Total	2.95	.31	71

Test of assumptions

Levene's test of equality of error variances was non-significant ($F(1, 69) = .509$, $p < .478$) meaning it is safe to assume homogeneity of variances in the data set.

Between-subject effects

ANOVA did not reveal a significant difference between groups ($F(1, 69) = 2.811$, $p < .098$, partial $\eta^2 = .039$). The ANOVA had weak power .380.

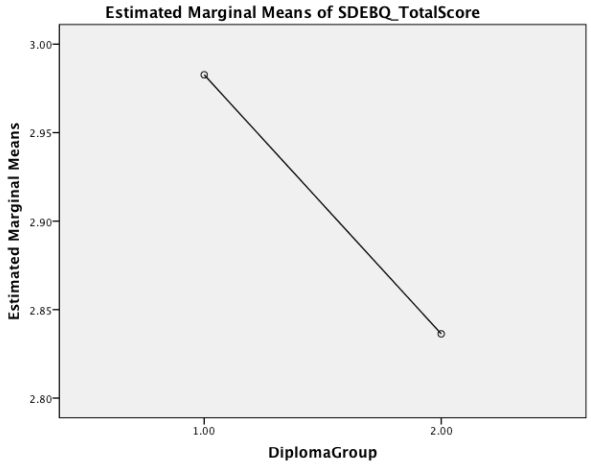
Estimated marginal means

The following table provides the estimates, along with standard deviations and confidence intervals.

Diploma Group	*Mean*	*Std. Error*	*95% Confidence Interval*	
			Lower Bound	Upper Bound
IB Graduates	2.98	.041	2.900	3.065
Non-IB Graduates	2.84	.077	2.683	2.990

Profile plots

Below is a plot of the estimated marginal means, which graphically demonstrates the lower average scores for the IB graduates compared to the non-IB graduates.



SEBQ MANOVA

Descriptive statistics

For the SEBQ MANOVA, group 1 included 55 IB graduates and group 2 had 16 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the totals for each factor are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

	Diploma Group	*Mean*	*Std. Deviation*	*N*
Seek Single Answers	IB	2.97	.44	55
	Non-IB	2.71	.45	16
	Total	2.91	.45	71
Avoid Integration	IB	3.01	.41	55
	Non-IB	2.85	.42	16
	Total	2.98	.42	71
Avoid Ambiguity	IB	3.07	.53	55
	Non-IB	2.68	.68	16
	Total	2.98	.58	71
Knowledge Certain	IB	2.85	.46	55
	Non-IB	2.89	.58	16
	Total	2.86	.49	71
Depend Authority	IB	2.78	.64	55
	Non-IB	2.98	.48	16
	Total	2.82	.62	71
Don't Criticize Authority	IB	2.65	.43	55
	Non-IB	2.63	.38	16
	Total	2.64	.41	71
Ability Learn	IB	2.53	.62	55
	Non-IB	2.34	.63	16
	Total	2.49	.63	71
Can't Learn How to Learn	IB	3.71	.53	55
	Non-IB	3.58	.49	16
	Total	3.68	.52	71
Success Not Hard Work	IB	3.52	.53	55
	Non-IB	3.28	.64	16
	Total	3.46	.55	71
Learn First Time	IB	2.78	.47	55
	Non-IB	2.50	.57	16
	Total	2.71	.50	71
Learn Quick	IB	2.79	.35	55
	Non-IB	2.96	.46	16
	Total	2.83	.38	71
Concentrated Effort	IB	3.00	.68	55
	Non-IB	2.25	.73	16
	Total	2.83	.76	71

Test of assumptions

Neither Box's test of equality of covariance matrices nor Levene's tests of equality of error variances was significant (See Appendix) suggesting that the assumptions of the homogeneity of variances-covariances and homoscedasity are tenable.

Box's Test of Equality of Covariance Matrices

Box's M	*110.381*
F	.957
df1	78
df2	2516.607
Sig.	.586

Levene's Test of Equality of Error Variances

	F	*df1*	*df2*	*Sig.*
Seek Single Answers	.447	1	69	.506
Avoid Integration	.002	1	69	.961
Avoid Ambiguity	2.720	1	69	.104
Knowledge Certain	1.710	1	69	.195
Depend Authority	1.687	1	69	.198
Don't Criticize Authority	.031	1	69	.860
Ability to Learn	.039	1	69	.844
Can' t Learn How to Learn	.444	1	69	.507
Success Not Hard Work	.735	1	69	.394
Learn First Time	1.636	1	69	.205
Learn Quick	1.942	1	69	.168
Concentrated Effort	.468	1	69	.496

Multivariate test

The multivariate test revealed a significant difference between groups ($\Lambda = .857$, $F(12, 58) = 4.142$, $p < .000$, partial $\eta^2 = .461$). The MANOVA had strong power .998.

The table of between-subject effects below shows that factors 1, 3, and 12 present significant differences between the two groups however all the effects are relatively small as can be noted in the Partial Eta Squared column of the following table. As can be seen in the same table, observed power for each factor was relatively weak. Factors 1, 3, and 12 represent the variables with the greatest effect size and the strongest power.

Source	*Dependent Variable*	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
Diploma Group	1. Seek Single Answers	.856	1	.856	4.420	.039
	2. Avoid Integration	.317	1	.317	1.842	.179
	3. Avoid Ambiguity	1.925	1	1.925	6.035	.017
	4. Knowledge Certain	.014	1	.014	.059	.808
	5. Depend Authority	.532	1	.532	1.424	.237
	6. Don't Criticize Authority	.007	1	.007	.039	.843
	7. Ability Learn	.417	1	.417	1.064	.306
	8. Can't Learn How to Learn	.223	1	.223	.812	.371
	9. Success Not Hard Work	.696	1	.696	2.375	.128
	10. Learn First Time	.942	1	.942	3.899	.052
	11. Learn Quick	.389	1	.389	2.701	.105
	12. Concentrated Effort	6.972	1	6.972	14.577	.000
Error	1. Seek Single Answers	13.367	69	.194		
	2. Avoid Integration	11.859	69	.172		
	3. Avoid Ambiguity	22.007	69	.319		
	4. Knowledge Certain	16.522	69	.239		
	5. Depend Authority	25.768	69	.373		
	6. Don't Criticize Authority	11.954	69	.173		
	7. Ability Learn	27.068	69	.392		
	8. Can't Learn How to Learn	18.935	69	.274		
	9. Success Not Hard Work	20.216	69	.293		
	10. Learn First Time	16.679	69	.242		
	11. Learn Quick	9.926	69	.144		
	12. Concentrated Effort	33.000	69	.478		
Total	1. Seek Single Answers	615.400	71			
	2. Avoid Integration	640.719	71			
	3. Avoid Ambiguity	654.560	71			
	4. Knowledge Certain	596.944	71			
	5. Depend Authority	592.500	71			
	6. Don't Criticize Authority	508.000	71			
	7. Ability Learn	466.250	71			
	8. Can't Learn How to Learn	980.080	71			
	9. Success Not Hard Work	873.250	71			
	10. Learn First Time	540.444a	71			
	11. Learn Quick	577.080b	71			

	12. Concentrated Effort	609.000c	71

Source	*Dependent Variable*	*Partial Eta Squared*	*Observed Power*
Diploma Group	1. Seek Single Answers	.060	.545
	2. Avoid Integration	.026	.268
	3. Avoid Ambiguity	.080	.678
	4. Knowledge Certain	.001	.057
	5. Depend Authority	.020	.218
Diploma Group	6. Don't Criticize Authority	.001a	.054
	7. Ability Learn	.015b	.174
	8. Can't Learn How to Learn	.012c	.144
	9. Success Not Hard Work	.033d	.330
	10. Learn First Time	.053e	.495
	11. Learn Quick	.038f	.367
	12. Concentrated Effort	.174g	.964

Estimated marginal means

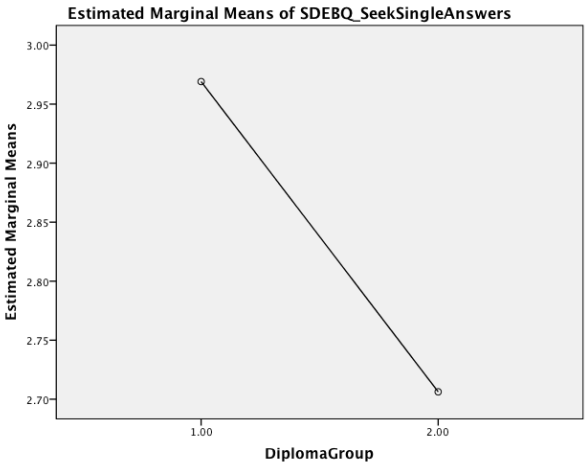
Following is a table with the means, along with standard deviations and confidence intervals.

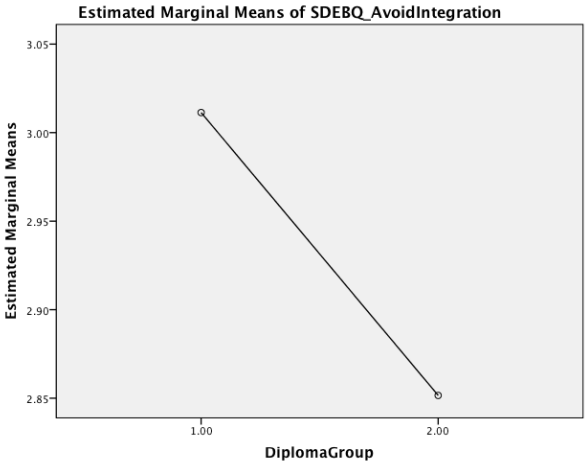
Dependent Variable	*Diploma Group*	*Mean*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	Upper Bound
1. Seek Single Answers	IB	2.97	.06	2.851	3.087
	Non-IB	2.71	.11	2.487	2.926
2. Avoid Integration	IB	3.01	.06	2.900	3.123
	Non-IB	2.85	.10	2.645	3.058
3. Avoid Ambiguity	IB	3.07	.08	2.917	3.221
	Non-IB	2.68	.14	2.393	2.957
4. Knowledge Certain	IB	2.85	.07	2.720	2.983
	Non-IB	2.89	.12	2.641	3.129
5. Depend Authority	IB	2.78	.08	2.613	2.942
	Non-IB	2.98	.15	2.680	3.289
6. Don't Criticize Authority	IB	2.65	.06	2.537	2.760
	Non-IB	2.63	.10	2.417	2.833
7. Ability to Learn	IB	2.53	.08	2.359	2.696
	Non-IB	2.34	.16	2.031	2.656
8. Can't Learn How to Learn	IB	3.71	.07	3.568	3.850
	Non-IB	3.58	.13	3.314	3.836
9. Success Not Hard Work	IB	3.52	.07	3.373	3.664
	Non-IB	3.28	.14	3.011	3.551
10. Learn First Time	IB	2.78	.07	2.644	2.908

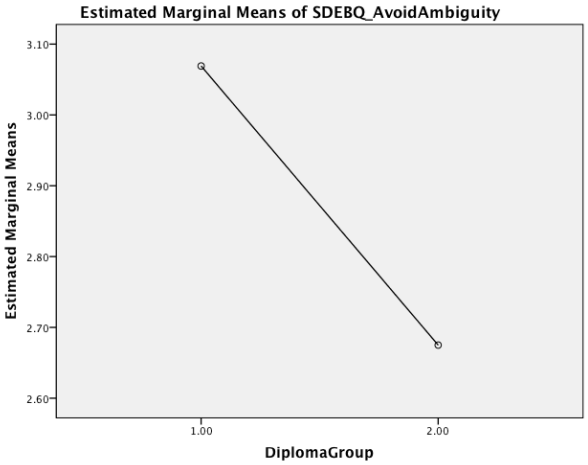
11. Learn Quick	Non-IB	2.50	.12	2.255	2.745
	IB	2.79	.05	2.683	2.887
12. Concentrated Effort	Non-IB	2.96	.10	2.773	3.152
	IB	3.00	.09	2.814	3.186
	Non-IB	2.25	.17	1.905	2.595

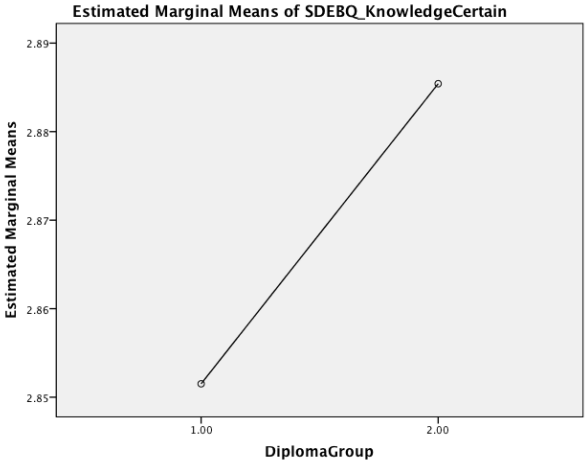
Profile plots

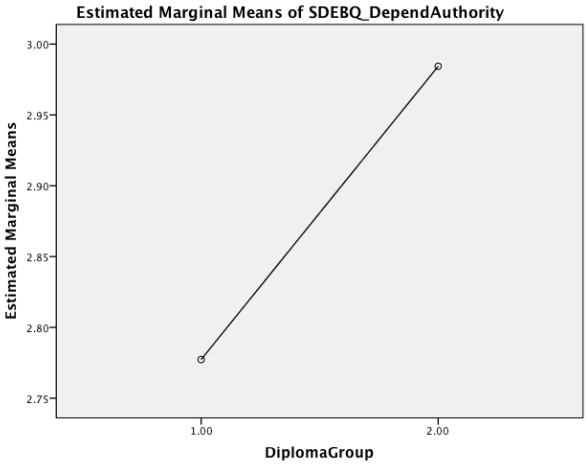
Below are the plots of the estimated means. There is an alternating trend apparent across all 12 factors.

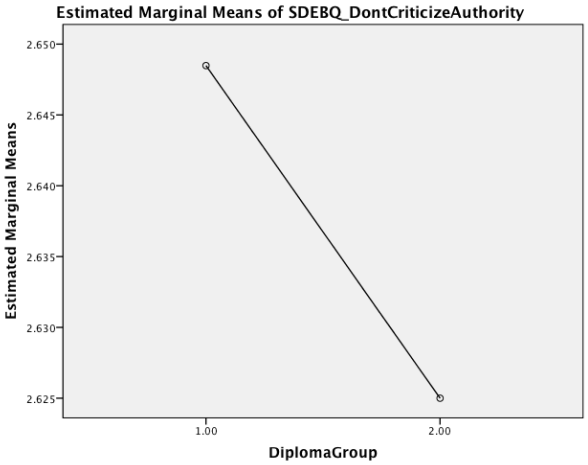


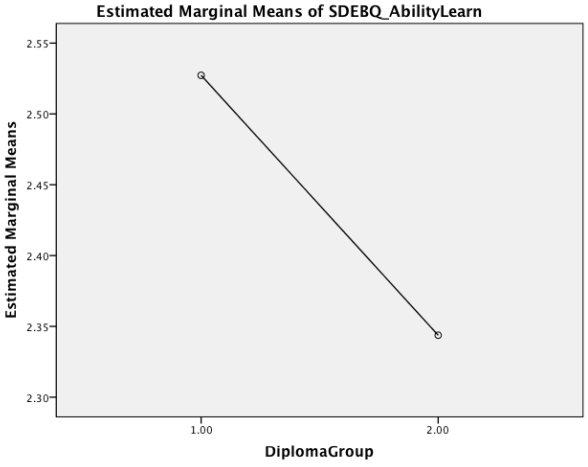


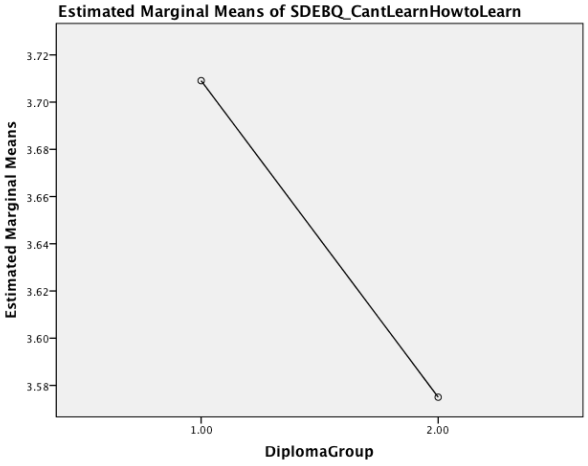

Estimated Marginal Means of SDEBQ_AvoidAmbiguity
Estimated Marginal Means
3.10
3.00
2.90
2.80
2.70
2.60
1.00
2.00
DiplomaGroup

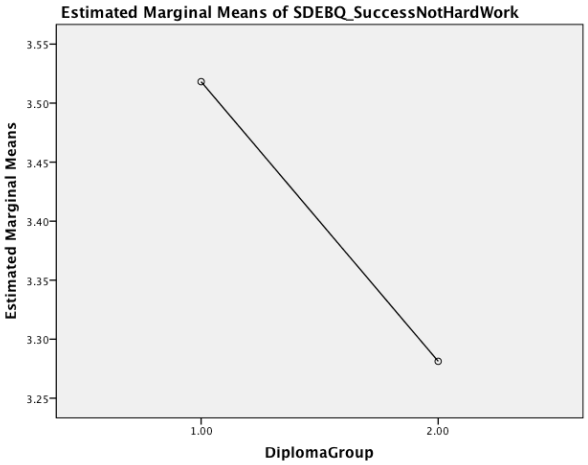

Estimated Marginal Means of SDEBQ_KnowledgeCertain
Estimated Marginal Means
2.89
2.88
2.87
2.86
2.85
1.00
2.00
DiplomaGroup

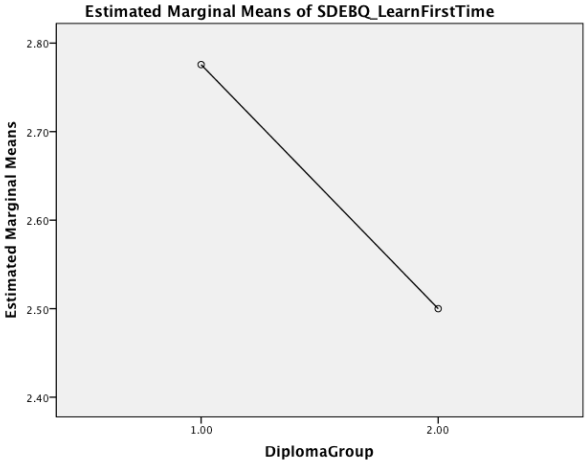

Estimated Marginal Means of SDEBQ_DependAuthority
Estimated Marginal Means
3.00
2.95
2.90
2.85
2.80
2.75
1.00
2.00
DiplomaGroup

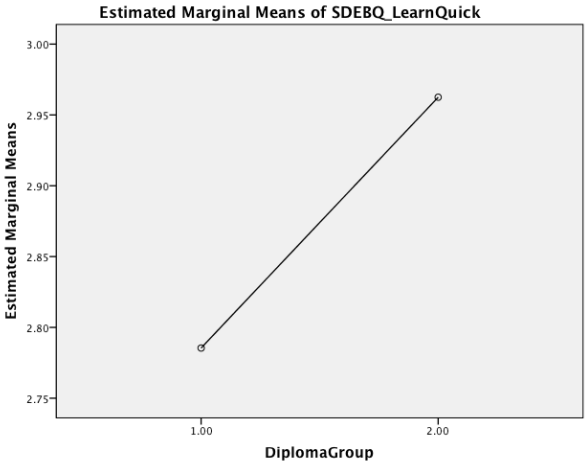

Estimated Marginal Means of SDEBQ_DontCriticizeAuthority
Estimated Marginal Means
2.650
2.645
2.640
2.635
2.630
2.625
1.00
2.00
DiplomaGroup

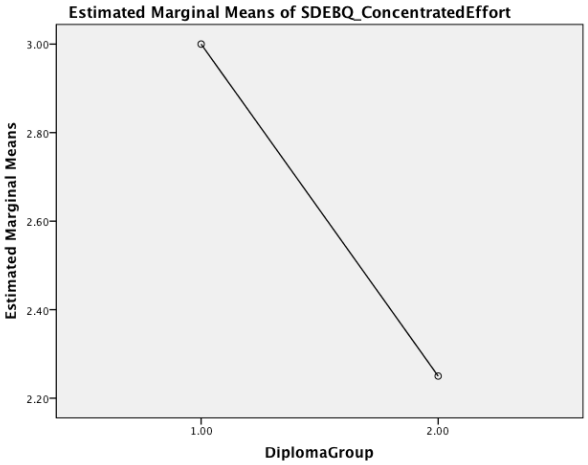

Estimated Marginal Means of SDEBQ_AbilityLearn
Estimated Marginal Means
2.55
2.50
2.45
2.40
2.35
2.30
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SDEBQ_CantLearnHowtoLearn
Estimated Marginal Means
3.72
3.70
3.68
3.66
3.64
3.62
3.60
3.58
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SDEBQ_SuccessNotHardWork
Estimated Marginal Means
3.55
3.50
3.45
3.40
3.35
3.30
3.25
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SDEBQ_LearnFirstTime
Estimated Marginal Means
2.80
2.70
2.60
2.50
2.40
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SDEBQ_LearnQuick
Estimated Marginal Means
3.00
2.95
2.90
2.85
2.80
2.75
1.00
2.00
DiplomaGroup



LPQ ANOVA

Descriptive statistics

For the LPQ ANOVA, group 1 included 46 IB graduates and group 2 had 15 non-IB graduates.

The means and standard deviations for the IB and Non-IB diploma as well as the total score are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Test of assumptions

Levene's test of equality of error variances was non-significant ($F(2, 103) = .647$, $p < .526$) meaning it is safe to assume homogeneity of variances in the data set.

Between-subject effects

ANOVA did not reveal a significant difference between groups ($F(1, 59) = 1.500$, $p < .226$ partial $\eta^2 = .025$). The ANOVA had weak power .226.

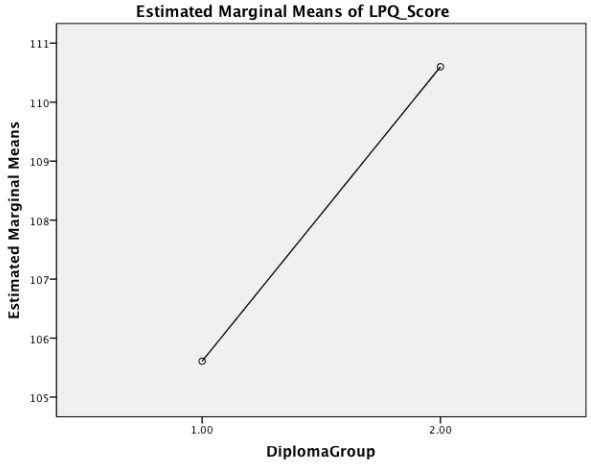
Estimated marginal means

Following is a table with the means, along with standard deviations and confidence intervals.

Diploma Group	*Mean*	*Std. Error*	*95% Confidence Interval*	
			Lower Bound	Upper Bound
IB Graduates	105.61	2.02	101.565	109.652
Non-IB Graduates	110.60	3.54	103.519	117.681

Profile plots

Below is the plot of the estimated means, which shows the lower average scores for IB graduates versus non-IB graduates.



LPQ MANOVA

Descriptive statistics

For the LPQ MANOVA, group 1 included 46 IB graduates and group 2 had 15 non-IB graduates.
The means and standard deviations for the IB and Non-IB diploma as well as the totals for each factor are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

	Diploma Group	*Mean*	*Std. Deviation*	*N*
Surface Motive	IB	15.46	3.55	46
	Non-IB	17.73	4.37	15
	Total	16.02	3.86	61
Surface Approach	IB	16.48	4.09	46
	Non-IB	17.40	4.49	15

Deep Motive	Total	16.70	4.17	61
	IB	15.96	4.80	46
	Non-IB	16.40	4.49	15
	Total	16.07	4.69	61
Deep Approach	IB	20.78	3.94	46
	Non-IB	23.73	3.83	15
	Total	21.51	4.09	61
Achievement Motive	IB	17.07	3.67	46
	Non-IB	16.00	4.84	15
	Total	16.80	3.97	61
Achievement Approach	IB	19.87	4.53	46
	Non-IB	19.33	5.26	15
	Total	19.74	4.68	61

Test of assumptions

Box's Test of Equality of Covariance Matrices was significant (M = 41.83, $F(21, 2563) = 1.652$, $p < .031$) suggesting that the assumption of the homogeneity of variances-covariances has been violated. The Levene's tests did not report any significant difference, which suggests that we can safely assume equality of error variances.

Box's Test of Equality of Covariance Matrices

Box's M	*41.825*
F	1.652
df1	21
df2	2563.192
Sig.	.031

Levene's Test of Equality of Error Variances

	F	*df1*	*df2*	*Sig.*
SM	1.046	1	59	.311
SS	.407	1	59	.526
DM	.611	1	59	.438
DS	.007	1	59	.933
AM	1.293	1	59	.260
AS	.093	1	59	.761

Multivariate test

The multivariate test revealed a significant difference between groups ($\Lambda = .847$, $F(6, 54) = 1.620$, $p < .159$, partial $\eta^2 = .153$). The MANOVA had moderate power .571.

Between-subject effects

The table of between-subject effects below shows that the factors 1-Surface Motivation and 4-Deep Approach present a significant difference between the two groups however all the effects are relatively small as can be noted in the Partial Eta Squared column. Further, powers are weak across all the factors. The only exceptions being factors 1 and 4, which have the largest partial $\eta^2$and the most power at .72.

Source	*Dependent Variable*	*Type III Sumdf of Squares*		*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	1. Surface Motivation	58.637	1	58.637	4.146	.046	.066
	2. Surface Approach	9.610	1	9.610	.548	.462	.009
	3. Deep Motivation	2.225	1	2.225	.100	.753	.002
	4. Deep Approach	98.486	1	98.486	6.437	.014	.098
	5. Achievement Motivation	12.835	1	12.835	.812	.371	.014
	6. Achievement Approach	3.253	1	3.253	.147	.703	.002
Error	1. Surface Motivation	834.346	59	14.141			
	1. Surface Motivation	1035.078	59	17.544			
	2. Surface Approach	1317.513	59	22.331			
	3. Deep Motivation	902.759	59	15.301			
	4. Deep Approach	932.804	59	15.810			
	5. Achievement Motivation	1308.551	59	22.179			
Total	6. Achievement Approach	16541.000	61				
	1. Surface Motivation	18067.000	61				
	2. Surface Approach	17064.000	61				
	3. Deep Motivation	29220.000	61				
	4. Deep Approach	18169.000	61				
	5. Achievement Motivation	25076.000	61				

Source	*Dependent Variable*	*Observed Power*
Diploma Group	1. Surface Motivation	.517
	2. Surface Approach	.113
	3. Deep Motivation	.061
	4. Deep Approach	.704
	5. Achievement Motivation	.144
	6. Achievement Approach	.066

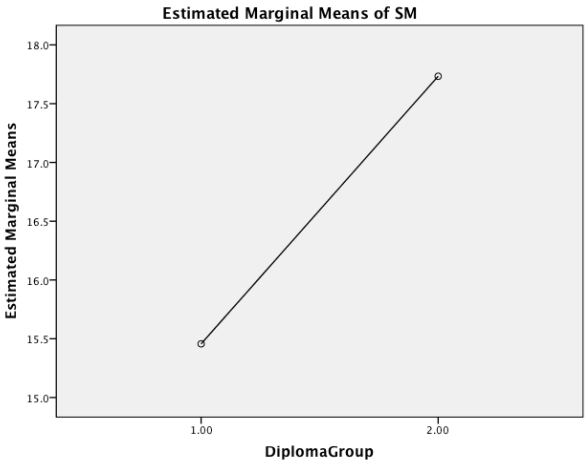
Estimated marginal means

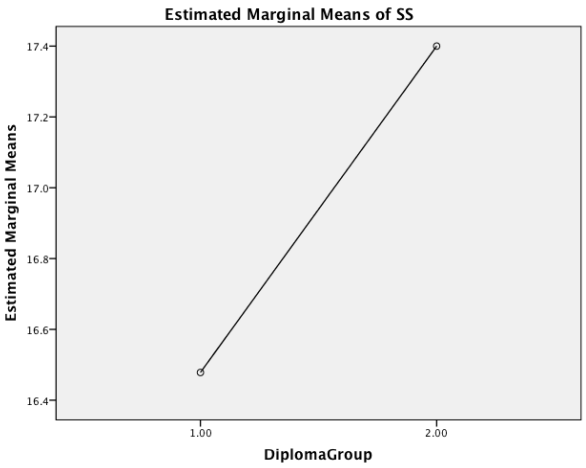
Following is a table with the means, along with standard deviations and confidence intervals.

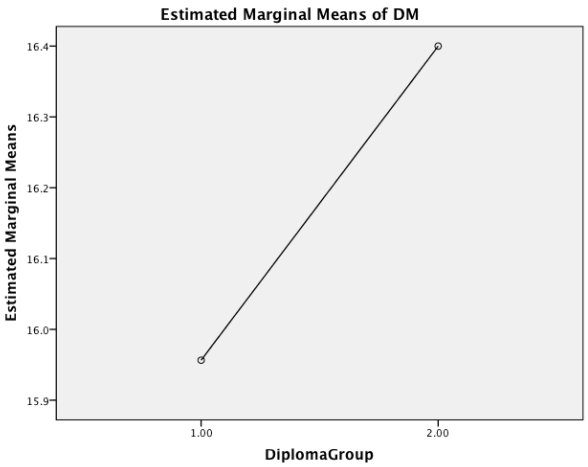
Dependent Variable	*Diploma Group*	*Mean*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	Upper Bound
1. Surface Motivation	IB	15.46	.55	14.347	16.566
	Non-IB	17.73	.97	15.790	19.676
2. Surface Approach	IB	16.48	.62	15.243	17.714
	Non-IB	17.40	1.08	15.236	19.564
3. Deep Motivation	IB	15.96	.70	14.562	17.351
	Non-IB	16.40	1.22	13.959	18.841
4. Deep Approach	IB	20.78	.58	19.629	21.937
	Non-IB	23.73	1.01	21.712	25.754
5. Achievement Motivation	IB	17.07	.59	15.892	18.238
	Non-IB	16.00	1.03	13.946	18.054
6. Achievement Approach	IB	19.87	.69	18.480	21.259
	Non-IB	19.33	1.21	16.900	21.766

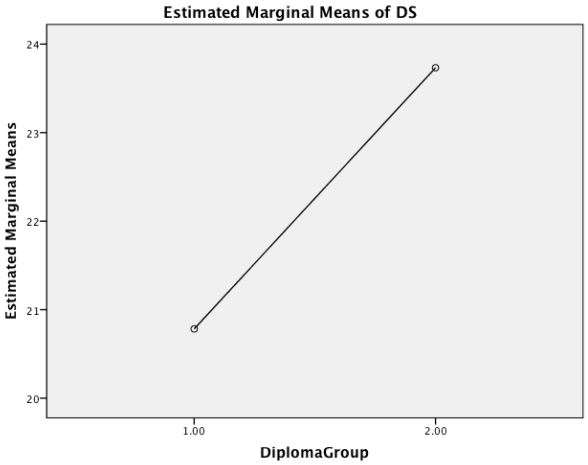
Profile plots

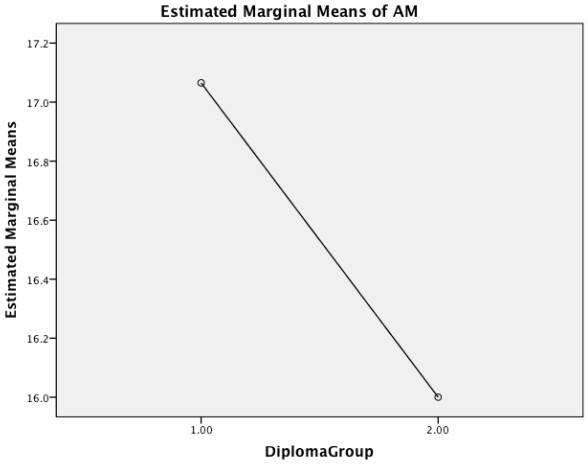
Below are the plots of the estimated means. An alternating trend is apparent across the 3 sets of factors. The non-IB average score is higher on the surface levels, while the IB graduates score higher on the achievement levels.


Estimated Marginal Means of SM
Estimated Marginal Means
18.0
17.5
17.0
16.5
16.0
15.5
15.0
1.00
2.00
DiplomaGroup


Estimated Marginal Means of SS
Estimated Marginal Means
17.4
17.2
17.0
16.8
16.6
16.4
1.00
2.00
DiplomaGroup


Estimated Marginal Means of DM
Estimated Marginal Means
16.4
16.3
16.2
16.1
16.0
15.9
1.00
2.00
DiplomaGroup





VNOS-C ANOVA

For the VNOS-C ANOVA, group 1 included 31 IB graduates and group 2 had 12 non-IB graduates.
The means and standard deviations for the IB and Non-IB diploma as well as the total score are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

Descriptive statistics

		N
Diploma Group	IB	31
	Non-IB	12

Diploma Group	*Mean*	*Std. Deviation*	*N*
IB Graduates	235.26	15.27	31
Non-IB Graduates	239.00	17.39	12

Total	236.30	15.77	43

Test of assumptions

Levene's test of equality of error variances was non-significant ($F(1, 41) = .008$, $p < .927$) meaning it is safe to assume homogeneity of variances in the data set.

Tests of between-subjects effects

ANOVA did not reveal a significant difference between groups ($F(1, 41) = .481$, $p < .492$, partial $\eta^2 = .012$). The ANOVA had weak power .104.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Diploma Group	121.134	1	121.134	.481	.492	.012
Error	10323.935	41	251.803			
Total	2411513.000	43				

Parameter Estimates

Parameter	*B*	*Std. Error*	*t*	*Sig.*	*95% Confidence Interval*		*Partial Eta Squared*
					Lower Bound	Upper Bound	
Intercept	239.000	4.581	52.174	.000	229.749	248.251	.985
IB Graduates	-3.742	5.395	-.694	.492	-14.637	7.154	.012

Parameter	*Observed Power*
Intercept	1.000
IB Graduates	.104
Non-IB Graduates	.

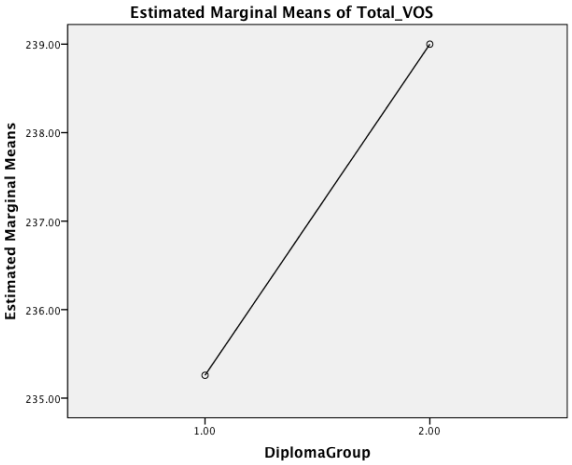
Estimated marginal means

The following table provides the estimates, along with standard deviations and confidence intervals.

Diploma Group	*Mean*	*Std. Error*	*95% Confidence Interval*	
			Lower Bound	Upper Bound
IB Graduates	235.26	2.85	229.502	241.014
Non- IB Graduates	239.00	4.58	229.749	248.251

Profile plots

Below is a plot of the estimated marginal means, which graphically demonstrates the lower average scores for the IB graduates compared to the non-IB graduates.



VNOS-C MANOVA

Descriptive statistics

For the SEBQ MANOVA, group 1 included 31 IB graduates and group 2 had 12 non-IB graduates.
The means and standard deviations for the IB and Non-IB diploma as well as the totals for each factor are listed in the tables below. Bivariate correlations can be found in the Appendix. Factors and total scores are highly interrelated.

	Diploma Group	*Mean*	*Std. Deviation*	*N*
Tentativeness	IB Graduate	8.77	1.28	31
	Non-IB Graduate	9.33	2.02	12
	Total	8.93	1.52	43
Nature & Observations	IB Graduate	16.35	2.73	31
	Non-IB Graduate	17.67	3.55	12
	Total	16.72	2.99	43
Scientific & Method	IB Graduate	16.84	2.25	31
	Non-IB Graduate	16.83	3.66	12
	Total	16.84	2.67	43
Theories & Laws	IB Graduate	41.29	6.45	31
	Non-IB Graduate	41.17	6.13	12
	Total	41.26	6.29	43
Imagination	IB Graduate	16.61	4.14	31
	Non-IB Graduate	16.92	3.75	12
	Total	16.70	3.99	43
Validation	IB Graduate	22.13	2.54	31
	Non-IB Graduate	22.00	1.86	12

Subjectivity & Objectivity	Total	22.09	2.35	43
	IB Graduate	95.06	8.10	31
	Non-IB Graduate	97.58	9.99	12
	Total	95.77	8.62	43

Test of Assumptions

Box's Test of Equality of Covariance Matrices was not significant (M = 43.60, $F(28, 1598) = 1.148$, $p < .272$) suggesting that the assumption of the homogeneity of variances-covariances is tenable.

The table below presents the Levene's Test of equality of error variances for each factor of the VNOS-C inventory. None of the reported *F* statistics were significant therefore it is safe to assume equality of error variances in our multivariate data set.

	F	*df1*	*df2*	*Sig.*
Tentativeness	2.451	1	41	.125
Nature & Observations	.232	1	41	.633
Scientific & Method	3.628	1	41	.064
Theories & Laws	.000	1	41	.989
Imagination	.114	1	41	.737
Validation	3.286	1	41	.077
Subjectivity & Objectivity	.902	1	41	.348

Multivariate Tests

The multivariate test did not reveal a significant difference between groups ($\Lambda = .939$, $F(7, 35) = .323$, $p < .938$, partial $\eta^2 = .061$). The MANOVA had strong power .132.

Effect		*Value*	*F*	*Hypothesis df*	*Error df*	*Sig.*	*Partial Eta Squared*
Diploma Group	Pillai's Trace	.061	.323	7.000	35.000	.938	.061
	Wilks' Lambda	.939	.323	7.000	35.000	.938	.061
	Hotelling's Trace	.065	.323	7.000	35.000	.938	.061
	Roy's Largest Root	.065	.323	7.000	35.000	.938	.061

Tests of between-subjects effects

The table of between-subject effects below shows that none of the tests of the factors presented a significant difference between the two groups however all the effects are relatively small as can be noted in the Partial Eta Squared column of the

following table. As can be seen in the same table, observed power for each factor was also very weak.

Source	*Dependent Variable*	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
Diploma Group	Tentativeness	2.705	1	2.705	1.179	.284
	Nature & Observations	14.888	1	14.888	1.687	.201
	Scientific & Method	.000	1	.000	.000	.995
	Theories & Laws	.132	1	.132	.003	.955
	Imagination	.798	1	.798	.049	.826
	Validation	.144	1	.144	.026	.874
	Subjectivity & Objectivity	54.887	1	54.887	.734	.396
Error	Tentativeness	94.086	41	2.295		
	Nature & Observations	361.763	41	8.823		
	Scientific & Method	299.860	41	7.314		
	Theories & Laws	1660.054	41	40.489		
	Imagination	668.272	41	16.299		
	Validation	231.484	41	5.646		
	Subjectivity & Objectivity	3064.788	41	74.751		
Total	Tentativeness	3526.000	43			
	Nature & Observations	12399.000	43			
	Scientific & Method	12490.000	43			
	Theories & Laws	74848.000	43			
	Imagination	12658.000	43			
	Validation	21220.000	43			
	Subjectivity & Objectivity	397490.000	43			

Source	*Dependent Variable*	*Partial Eta Squared*	*Observed Power*
Diploma Group	Tentativeness	.028	.185
	Nature & Observations	.040	.245
	Scientific & Method	.000	.050
	Theories & Laws	.000	.050
	Imagination	.001	.055
	Validation	.001	.053
	Subjectivity & Objectivity	.018	.133

Parameter Estimates

Dependent Variable	*Parameter*	*B*	*Std. Error*	*t*	*Sig.*	*95% Confidence Interval*
						Lower Bound

Tentativeness	Intercept	9.333	.437	21.343	.000	8.450
	IB Graduates	-.559	.515	-1.086	.284	-1.599
Nature & Observations	Intercept	17.667	.857	20.603	.000	15.935
	IB Graduates	-1.312	1.010	-1.299	.201	-3.351
Scientific & Method	Intercept	16.833	.781	21.562	.000	15.257
	IB Graduates	.005	.919	.006	.995	-1.851
Theories & Laws	Intercept	41.167	1.837	22.411	.000	37.457
	IB Graduates	.124	2.163	.057	.955	-4.245
Imagination	Intercept	16.917	1.165	14.515	.000	14.563
	IB Graduates	-.304	1.373	-.221	.826	-3.076
Validation	Intercept	22.000	.686	32.073	.000	20.615
	IB Graduates	.129	.808	.160	.874	-1.502
Subjectivity & Objectivity	Intercept	97.583	2.496	39.098	.000	92.543
	IB Graduates	-2.519	2.939	-.857	.396	-8.455

Dependent Variable	*Parameter*	*95% Confidence Interval*	*Partial Eta Squared*	*Observed Power*
		Upper Bound		
Tentativeness	Intercept	10.216	.917	1.000
	IB Graduates	.481	.028	.185
Nature & Observations	Intercept	19.398	.912	1.000
	IB Graduates	.728	.040	.245
Scientific & Method	Intercept	18.410	.919	1.000
	IB Graduates	1.862	.000	.050
Theories & Laws	Intercept	44.876	.925	1.000
	IB Graduates	4.493	.000	.050
Imagination	Intercept	19.270	.837	1.000
	IB Graduates	2.468	.001	.055
Validation	Intercept	23.385	.962	1.000
	IB Graduates	1.761	.001	.053
Subjectivity & Objectivity	Intercept	102.624	.974	1.000
	IB Graduates	3.418	.018	.133

Estimated marginal means

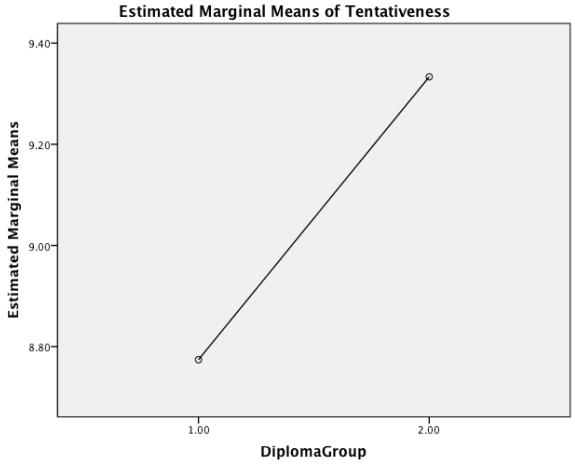
Following is a table with the means, along with standard deviations and confidence intervals.

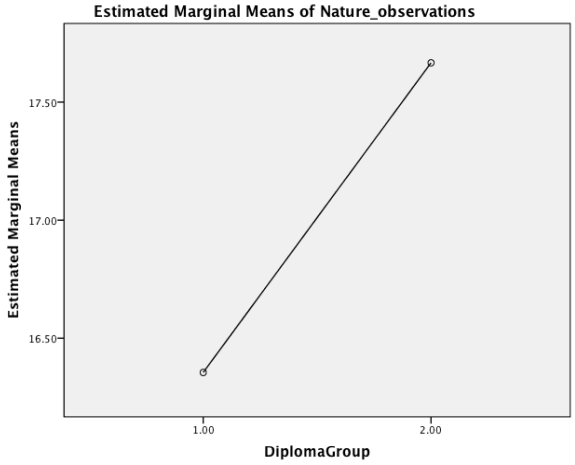
Dependent Variable	*Diploma Group*	*Mean*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	Upper Bound
Tentativeness	IB Graduates	8.77	.27	8.225	9.324
	Non-IB Graduates	9.33	.44	8.450	10.216
Nature & Observations	IB Graduates	16.36	.53	15.277	17.432
	Non-IB Graduates	17.67	.86	15.935	19.398

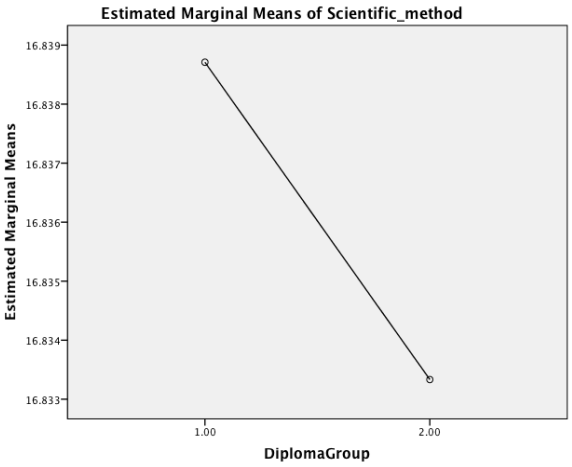
Scientific & Method	IB Graduates	16.84	.49	15.858	17.820
	Non-IB Graduates	16.83	.78	15.257	18.410
Theories & Laws	IB Graduates	41.29	1.14	38.982	43.598
	Non-IB Graduates	41.17	1.84	37.457	44.876
Imagination	IB Graduates	16.61	.73	15.149	18.077
	Non-IB Graduates	16.92	1.17	14.563	19.270
Validation	IB Graduates	22.13	.43	21.267	22.991
	Non-IB Graduates	22.00	.69	20.615	23.385
Subjectivity & Objectivity	IB Graduates	95.07	1.55	91.928	98.201
	Non-IB Graduates	97.58	2.45	92.543	102.624

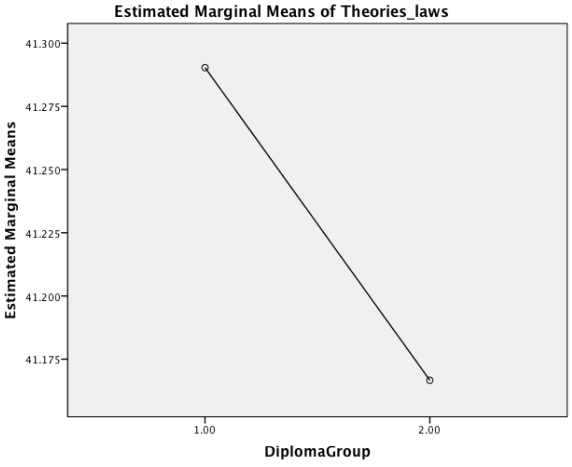
Profile plots

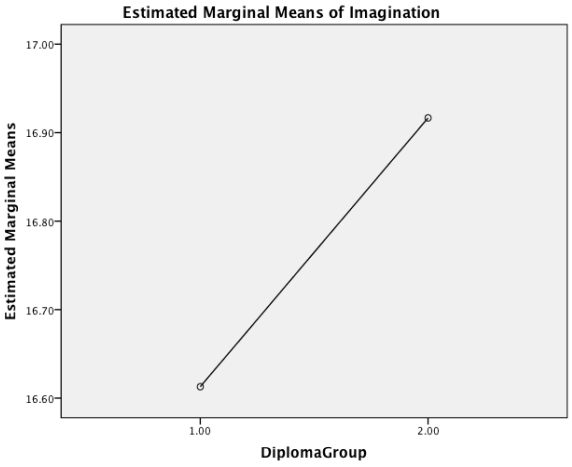
Below are the plots of the estimated means. There is an alternating trend apparent across all 7 factors.

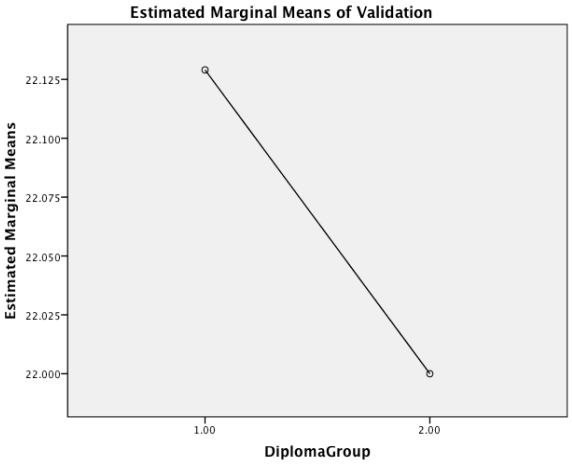


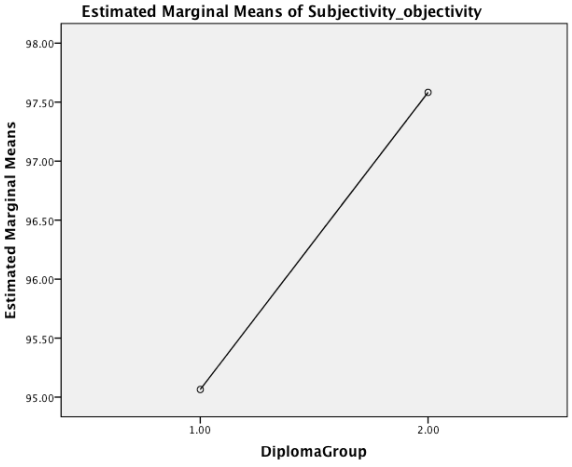



Estimated Marginal Means of Scientific_method
Estimated Marginal Means
16.839
16.838
16.837
16.836
16.835
16.834
16.833
1.00
2.00
DiplomaGroup


Estimated Marginal Means of Theories_laws
Estimated Marginal Means
41.300
41.275
41.250
41.225
41.200
41.175
1.00
2.00
DiplomaGroup


Estimated Marginal Means of Imagination
Estimated Marginal Means
17.00
16.90
16.80
16.70
16.60
1.00
2.00
DiplomaGroup


Estimated Marginal Means of Validation
Estimated Marginal Means
22.125
22.100
22.075
22.050
22.025
22.000
1.00
2.00
DiplomaGroup


Estimated Marginal Means of Subjectivity_objectivity
Estimated Marginal Means
98.00
97.50
97.00
96.50
96.00
95.50
95.00
1.00
2.00
DiplomaGroup