

Mathematics Transition from MYP to the IB Diploma Programme

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Literature Review

Economic globalization since the early 1900s has influenced multinational companies to expand their business by establishing International Baccalaureate schools. This influence has placed a high demand for international professionals around the world as companies have expanded their IB school business to Eastern Europe, Latin America, East Asia, and the countries around. In developing countries, people respond negatively to the local schools because of their poor-quality education, not meeting international education standards, and complicated school systems. However, many expatriate parents living outside their native countries prefer sending their children to international schools in order to effectively nurture their minds through quality education. One of the potential reasons why expatriate parents put their trust in international baccalaureate institutions is that they use English for their language instructions, and this peculiar strategy meets international language requirements. Moreover, both local and expatriate parents wish to equip their children with the power of Mathematics along with English so that they can develop the ability to analyze and describe the world around them (Walker et al., 2014).

Mathematics has become a highly significant tool for students to develop problem-solving skills so that they can explore the world through the unique perception of mathematics. IB schools provide students with an opportunity to describe themselves as “mathematicians” or “artists” where they can enjoy learning and exploring different mathematical strategies and tactics in order to appreciate students’ intrinsic fascination with mathematics. In transitioning from the Middle Year Program (MYP) to the Diploma Program (DP) and the continuum of mathematics as a vital subject providing learners with a global language in all these years, it is recognized as a vehicle that supports exploration, inquiry, and discovery to make sense of the world around them (Tampubolon, 2017). It is viewed that students begin to use the language of mathematics as a way of thinking with the intention of becoming competent users of it. It is also intended while implementing the language of mathematics from MYP to DP in international baccalaureate school systems to oppose the thinking that the language of mathematics is only a series of equations to be memorized just to bring good results in the classrooms (IBO, “The MYP-DP Continuum,” 2010).

In the Middle Year Program (MYP), learners acquire mathematical and analytical skills through their ever-increasing abstraction level, which helps them construct their own meanings outside the world. They explore their own knowledge, understanding, abstraction capability, and personal experiences to construct and transfer meaning in real-life situations and realistic contexts (IB, 2009). To fulfil the

need for quality education from an international perspective, the International Baccalaureate Organization has developed a program with best practices concerning the language of Mathematics with the help of well-trained and qualified international market professional mathematicians from around the world. Due to the rise in demand for mathematics as a vital subject in the curriculum, the International Baccalaureate Organization launched its program in 1960. The statistical data of 2010 showed that approximately 2000 schools across the world adopted that program, and in the Asia Pacific, almost 400 schools implemented one or two programs of the IB organization (Wright et al., 2016).

Learning Culture

In 1980, the IB Middle Years Program (MYP) Mathematics program was first implemented with the complex structure of the program and seemingly little understood curriculum content based on little research (Bunnell, 2011). International Baccalaureate offers a key feature of openness to international mindedness through the continuum of mathematics as a tagline in order to promote IB programs. It offers value and cultural differences by implementing IB programs to appreciate distinct perspectives. These programs are uniquely equipped to help students recognize that every individual can be right and have the integrity to stand for their rights according to their values and beliefs. MYP Mathematics and DP Mathematics, from a philosophical perspective, have similar aims and objectives towards yielding critical and creative analytics as well as thinkers. DP Mathematics at all levels is designed for students with a passion for the language of mathematics for their preparation for university education in the future as professionals create assessments to allow Diploma Program Mathematics students to act as scientists or mathematicians by using their problem-solving skills (Successful STEM Education, 2013). The program aims to utilize all assessment-based content that is based on open-ended questions used as criteria to make students think of themselves as problem solvers. These assessments are specifically designed to enrich DP learners with 21st-century skills established through varied methods and approaches. Diploma students are presented with these assessments so that they can be trained to utilize their deeper creative and critical skills as well as analytical thinking (STEM Smart Brief, 2013).

Management of Transition from MYP to DP

The International Baccalaureate Organization (IBO) 2010 published research related to the continuum of Mathematics in IB regarding the transition process from MYP to DP. It is advised to the international baccalaureate schools that the mathematics curriculum for both MYP and DP should be implemented with horizontal as well as vertical planning to overcome the transition issue faced by IB practitioners as well as MYP and DP students. The purpose of both the planning strategies is to design integral units in every group of the respective program from different subjects that are being offered in the course, whether it is DP or MYP Mathematics course. Horizontal planning ensures that the curriculum of each subject in the adopted course is effectively linked to the other subjects that are offered in the course

at the same level. On the other hand, vertical planning of the mathematics course emphasizes fostering the student's ability to pursue the next levels of their course and education through a well-developed curriculum that must be comprised of criteria-based assessments such as inner assessments and external examinations. Moreover, the implementation of both plans requires a responsible school system backed by foreigners to meet the international requirements of education in mathematics (Daly et al., 2012). Based on careful planning, a school can smoothly perform the transition process from MYP to DP Mathematics, which would pave the way for future education for the students who wish to achieve their dreams of entering the fields related to Mathematics.

The International Baccalaureate Organization suggests creating and adopting pathways through which students can be classified at different levels. The IBO classifies the MYP Mathematics program into the Extended Mathematics (EM) program and the Standard Level (SL) Mathematics program. It is the responsibility of each school to classify different groups of students into different levels of MYP or DP according to learners' capabilities. Then, they should be placed in an SL or Extended Mathematics program. The Extended Mathematics (EM) program suggested by the International Baccalaureate is actually intended to prepare students who have the zeal to learn and explore mathematics, statistics, and the related fields to boost their knowledge and practice of mathematics so that they can qualify for enrollment in courses such as Higher Level (HL) and Standard Level (SL) Mathematics. Students of the Mathematics course have the opportunity to qualify for the Higher Level (HL) Diploma Program Mathematics. Moreover, the Standard Level (SL) Mathematics of Middle Years Program is planned and managed by IB Organization to facilitate students of mathematics who wish to join the Standard Level (SL) Diploma Program Mathematics for advanced studies in mathematics, engineering, finance, economics, and analytics and can also make a career in business as well as technology-related sectors (IBO, "Middle Years," 2015).

Challenges and Changes in the MYP-DP Transition

The continuum of mathematics in the IB program and its transition from the Middle Years Program to the Diploma Program has always been a challenge (Hallinger et al., 2011). The IBO Guide (2015) for Middle Years Program Mathematics suggested ways to overcome the transition difficulty by clearly emphasizing that Middle Years Program Mathematics has a goal to build on what "students learn during student-centred programs" implemented for quality primary education in Primary Years Program (Walker et al., 2014). Therefore, the biggest struggle and hindrance for an MYP teacher in the way to show the best results is that math teachers have to meet MYP objectives by managing the transition from PYP to MYP and then MYP to DP in a smooth manner through criteria-based assessments. Middle Years Program (MYP) Mathematics is intended to enable learners of the language of mathematics to communicate their analytical thinking and dwell on bigger concepts and methods by using different mathematical representations and symbols while they try to solve math problems. However, a new student who enrolls in the Middle Years Program Mathematics would find it difficult in the beginning to critically analyze the data and organize it into graphs, figures, and diagrams. They may also seemingly have difficulties in understanding what specific theory or particular conclusion

they have to learn to solve a complex math problem.

The transition from MYP to DP undergoes different challenges because the continuum of mathematics from MYP to DP has different orientations and distinctive goals. It was also reviewed that MYP Mathematics has no sufficient content compared to DP Mathematics, which hinders students of MYP from meeting the curricular expectations. IBO has developed both the IB programs, but the confusion in the curricular content of MYP in comparison to DP has led to thwarting exasperation as the IB practitioners try to resolve the challenges happening in this transition. As there exists a philosophical alignment, the transition from MYP to DP is a bit difficult as DP teachers complain about students not meeting the high expectations pertaining to their readiness (IB, 2009). Unfortunately, students with a strong desire to enter the arenas of engineering, finance, and related fields need mathematics but are unable to complete DP Higher Level (HL) Mathematics in 2 years and struggle with their future careers in DP HL Mathematics. In comparison to HL Mathematics, MYP Mathematics is a bit easier program but is not according to the higher-level standards. This is the reason why IB practitioners feel hesitant to adopt Middle Years Program Mathematics in international schools because of the non-compliance to international standards of the language of Mathematics, which looks set to acquire its dynamic curriculum continuum of IB mathematics (Barnes, 1998).

Hallinger et al. (2011), in their research “Program Transition Challenges in International Baccalaureate Schools”, determined the crucial factors that can cause a potential problem in the IB program while transitioning smoothly from the Middle Years Program to the Diploma Program. He, along with his fellow researchers, conducted research regarding the challenges IB practitioners and new MYP or DP students face and what changes should be effective for the smooth transition from MYP to DP in the continuum of mathematics. One of the suggestions the research put forward is that the DP mathematics program should reduce some skills as students of grade 11 and grade 12, while they finish the MYP Mathematics program, are not fully equipped with mathematical methods and approaches. Hence, the skills they have adopted from the university education are sometimes not enough to meet the high expectations of the DP teachers. Subsequently, a new MYP graduate who passes the program with an average grade would certainly have serious difficulties while he tries to pursue DP Mathematics courses (Visser, 2010).

Reasons Behind Challenges in the Transitioning Process

Hallinger et al. (2011), in their research, identified several possible reasons behind the challenges and difficulties in transitioning from MYP to DP. The first reason could be the unfamiliarity of a new DP student regarding the external examination criteria. An MYP graduate does not know that an external examination is the requirement of the DP to pass the final stage of the program. In Standard Level (SL) DP Mathematics, external examinations comprise two papers conducted on two different days of the same or sometimes different months, which MYP does not follow. These papers are of a certain

weight and equal importance to the final score of the DP students. On the other hand, MYP does not support any mandatory external examination for the final scoring of the MYP students. Based on these requirements, the majority of international baccalaureate schools offering the Middle Years Program do not adopt external examination criteria. This is the reason why some of the international baccalaureate schools have discontinued the MYP Mathematics program due to the limited perspectives and assessments in the curriculum (Dickson et al., 2020). In MYP Mathematics courses, criteria-based assessments are designed by the MYP teachers. These assessments are completely based on inquiry queries that are implemented in MYP Mathematics. These assessments are to effectively analyze the creative, critical, and analytical skills of students. Unlike MYP Mathematics, DP Mathematics courses in their external examinations do not include criteria-based assessments. Instead, these courses require students to answer real-life problems correctly, and they are graded with the best scores according to the number of correct answers (IBO, "Middle Years," 2015).

The second reason for the struggle may be the fast pace of the DP Mathematics program, which surprised the DP students. It is also viewed that DP Mathematics is very strict compared to MYP Mathematics in terms of timelines and deadlines to finish the curriculum. The program in its Group 5 courses of mathematics has obligations for the DP students to finish the program content before the deadline. Contrastive to that, MYP Mathematics teachers focus on the learning process and have no mandatory obligations regarding content completion within strict timelines. The essential idea is to strongly instill the knowledge and crucial concepts related to mathematics in an MYP learner's mind and embed the skills necessary for problem-solving skills. However, if an MYP teacher does not understand the expectations of the Diploma Program and the teacher delivering the courses while they adopt the DP Mathematics course, his/her students will encounter serious problems (IBO, "DP: Mathematics SL Guide," 2014).

Finally, the reason for the struggle in the transition from MYP to DP is internal assessment, such as external examinations. This assessment is an essential stage for passing the DP Mathematics courses and is the most challenging task. According to the IBO Guide (2014), both Standard and Higher Levels require internal assessment, which allows every individual learner of mathematics in IB to choose his topic and area of research independently and can apply any of the mathematical skills in the content of the curriculum. DP students are given a timeline of 20 hours to complete their assessment, and this task needs to be completed without the intervention of the DP mathematics teacher. In contrast, the Middle Years Program Mathematics does not force any time constraints on the completion of the internal assessment. Students can also consult with their MYP mathematics teacher if they encounter any difficulty (IBO, "Middle Years," 2015). Therefore, these differences in the transitioning process from MYP to DP become an issue for the MYP graduates in adapting to the high and demanding expectations of DP Mathematics courses.

Monitoring and Assessment

In the Middle Years Program (MYP), the implementation of mathematics in IB philosophy has four potential objectives that are evident in assessing the learners' pace of learning the language of mathematics. It is used as a criterion to help learners train themselves to draw conclusions from different perspectives and draw different forms of answers to solve real-life problems. It is important to understand that there are no fixed methods and no fixed tools through which mathematical problems can be solved, and their results can be evaluated until students communicate and explore mathematical problems by using their deductive reasoning (Maass et al., 2019). In IB programs, learners of the language of mathematics use varied mathematical representations and symbols from different perspectives so that they are able to think critically and creatively and draw prospective conclusions from the problems in realistic contexts. However, these are not the only ways to assess students' success rates; there should be harmony in all tasks to overcome the expectation gap in the IB curriculum and understand what affects the students' progress. Other aspects for determining the current level of understanding of students of the language of mathematics include feedback, understanding of students' embedded skills, approaches to learning (ATL) of MYP, and also feed-forward students receive. In this regard, a conscientiously planned transition process from MYP to DP needs to be considered regarding the nature and structure of summative assessments of the IB Middle Years Program and Diploma Program for Mathematics.

The continuity of assessment in the IB program is ensured due to the consideration of a few areas in both MYP and DP, which are the current level of student's understanding of certain skills and ATL's skills to assess the effectiveness of the IB curriculum. Keeping in consideration both the areas of students' understanding level, formative assessments are created to analyze ATL skill development and conceptual understanding of bigger concepts and methods of mathematics. Formative assessments to evaluate the conceptual understanding of a student of mathematics are designed through the embedded tasks integrated into the practice and learning environment of the classroom and are similar in both MYP and DP Mathematics (Black, 2018). However, ATL's assessment is only for analyzing the progression details; it is not a component of the assessment of the IB curriculum. ATL (Approaches To Learning) skillsets in Mathematics act as a bridge to provide students with a world to explore through the lens of IB that offers an opportunity to students of the language of mathematics to "articulate" and "reflect" on the process of learning. These skill sets help students demonstrate what they have learned about mathematics in real-world situations through meaningful assessments in both the MYP and DP Mathematics. Objective assessment is the component part in both the MYP and the DP through which mathematical understanding and effectiveness of curriculum are monitored. These assessments also help IB professionals to decide the direction of a mathematics teacher's support and guidance in classroom practice and help them identify the expectation gap in the transition process. The professionals then consider ways to minimize the expectation gap in IB schools (James, Embedding Formative Assessment in Classroom Practice, 2017).

DP Mathematics, however, does not consider ATL's skill sets as a separate identity for the assessment

but incorporates them as an opportunity for the students to learn about “how to learn.” A student’s success, if he finishes MYP Mathematics or DP Mathematics, depends on a dynamic system where ATL skills development is required for the formative and summative assessment. Black and Wiliam (2018) put forward their research about the implementation of formative assessment by taking Perrenoud’s suggestion that such assessment must be embedded within a wild field of theory of pedagogy that should be influenced by learning and instruction associated with the educational activities within the realm of classrooms. The suggestion explores how teachers within the classroom setting develop the productive relationship between summative and formative feedback of assessments implemented in classroom practice. This strategy enhances the validity and reliability of the classroom assessments. Moreover, they explored the model of pedagogy and how summative and formative assessments in the learning environment of the classroom add an appropriate weight to the role of classroom assessments as a component part of the pedagogy of learning and education (Black, 2018). Pendergast et al. (2014) questioned the pedagogical approaches while drawing on Reimers’ argument regarding highlighting an expectation gap between MYP and DP Mathematics programs. He argued that there is a consistent base of program alignment with pedagogical practice within the classroom environment in the continuum of Mathematics while transitioning the programs from MYP to DP. IB has emphasized the disjoint between the pedagogical shift of learning and educational reform in the area of classroom discourse through a number of publications regarding pedagogical directives and approaches within classroom practice (Pendergast et al., 2014).

Summative assessments in MYP and DP are criteria referenced to assess the discretion of the mathematics teacher and also the students’ final attainment level. In summative assessment, the assessed curriculum of the Diploma Program offers a goal to help students in their internal assessments and prepare them for their external examinations to pass the final stage of the DP Mathematics course. On the other hand, the main aim of the MYP assessments is to reflect on the achievement level of the students in mathematics, and the teachers create assessments accordingly. IB, in this regard, alludes that student should be prepared for their class tasks for summative assessments in the classroom practice to develop effective strategies and tactics for inquiry-based learning and external examinations in order to support a smooth transition from MYP to DP (IB, MYP, 2020).

Differences and Similarities Comparing IB Curriculum to Other Curricula

Middle Years Program Mathematics is structured specifically to help students begin inquiry and deepen their learning by utilizing 21st-century skills creatively as compared to the other curriculum implemented worldwide (Perry et al., 2018). The specific goal of MYP Mathematics is to teach students how to ask questions about big concepts and ideas so that they can think reflectively about the implementation and application of mathematical concepts and methods in real-life situations (IBO, “Middle Years,” 2015). Contrasting to MYP Mathematics, the Diploma Program or DP Mathematics has

its own distinctive nature and features. According to the Higher Level (HL) Guide (2014), the International Baccalaureate Organization presented regarding the Diploma Program Mathematics, the program offers courses with three different subdivisions: Mathematical Standard Level, Mathematical Higher Level, and Mathematical Studies. The goal of these levels is for students to prepare themselves with mathematical concepts, analytical thinking, and interpersonal and problem-solving skills as a major and significant part of their future studies.

The Standard Level (SL) DP Mathematics provides the challenging mathematical skills needed for its students to help them potentially thrive in their future studies in prospective fields such as chemistry, economics, business administration, psychology, etc. In the second option, the Higher Level (HL) DP Mathematics equips learners of the language of mathematics with the necessary skills, where the expert mathematicians develop challenging and complex problems so that the DP students can dwell in their prior schema for searching out effective solutions. Furthermore, the level of Mathematical Studies (MS) provides an opportunity for students who are passionate about pursuing their studies in Languages, Arts, Social Studies, and the Humanities. The option also best serves the students who wish to continue their studies in applied statistics as it is the largest component of the Diploma Program in International Baccalaureate (IBO, "DP: Mathematics HL Guide," 2014). Şengül (2015), for instance, compares the misconceptions of the complex concept of fractions of MoNE (Ministry of National Education) to misconceptions of fractions in the IB program by selecting the three subtopics of the curriculum relating to fractions that include partitioning, ordering, and addition. The study was conducted to determine whether different curricula cause any significant response patterns to different mathematics curricula. It is analyzed in the study that the subtle differences due to wrong and correct answer patterns across the two selected curricula were not the major ones. The results of the study also proved that the subtopics of fractions were way more challenging than other basic topics of mathematics (Şengül, 2015).

Concluding Observations-Smooth Transition from MYP to DP Mathematics

International baccalaureate schools around the world have been adept at the burgeoning demand of local and expatriate parents for high-quality mathematics education in MYP and DP with an international orientation. Therefore, over the past decade, IB schools have experienced a dramatic change in the IB curriculum of mathematics whilst adopting mainly two programs offered by IB, including the Middle Years Program and Diploma Program of Mathematics, to facilitate a smooth student transition from MYP to DP Mathematics. Based on the demand, IB schools have experienced rapid growth in schools taking on problems of IB programs, such as challenges in transitioning between MYP and DP that are embedded in curriculum implementation. This expectation gap in the IB curriculum is what IB professionals allude to as "curriculum disconnection" (Walker, 2018). The present review of the literature pertaining to the smooth transition from the Middle Years Program to the Diploma Program Mathematics identified potential aspects of discontinuity of learning while

transitioning from MYP to DP and presented suggestions for how IB professionals can minimize the expectation gap and effects of subtle differences in IB curriculum and schools. Studies have shown that a successful transition requires an interconnected network of the written curriculum, the mathematics curriculum that is being taught in IB schools, and the assessed curriculum. Researchers have conveyed the importance of a comprehensive, assessed, and well-planned curriculum with relevant inquiry-based tasks within classroom practice for the development of ATL's skillsets as well as for the preparation of formative, summative, internal assessments, external assessments, and external examinations that are supported by the evidence-based research. The expectation gap while transitioning between MYP to DP must be appraised in IB schools' mathematics curriculum to succinctly make it certain that all students of the language of mathematics are equally assessed and their progress is evaluated to ensure that the aims of transitioning process from MYP to DP are met.

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