A COMPARISON OF THE INTERNATIONAL BACCALAUREATE DIPLOMA PROGRAM (IBDP) AND THE MINISTRY OF NATIONAL EDUCATION PROGRAM (MoNEP) MATHEMATICS SYLLABUS IN THE CONTEXT OF METACOGNITION

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JÜRİ VE ENSTİTÜ ONAYI

NURSEMİN FERATLAR'ın "A Comparison Of The International Baccalaureate Diploma Program (IBDP) And The Ministry Of National Education Program (MONEP) Mathematics Syllabus In The Context Of Metacognition" başlıklı tezi 14.05.2024 tarihinde aşağıdaki jüri tarafından değerlendirilerek "Maltepe Üniversitesi Lisansüstü Eğitim ve Öğretim Yönetmeliği" nin ilgili maddeleri uyarınca Eğitim Bilimleri Anabilim Dalı Yüksek Lisans/Doktora/Sanatta Yeterlik tezi oy birliğiyle/oy çokluğuyla, başarılı/başarısız olarak kabul edilmiştir.

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ÖZET

ULUSLARARASI BAKALORYA DİPLOMA PROGRAMI (UBDP) VE MİLLİ EĞİTİM BAKANLIĞI (MEB) ORTAÖĞRETİM MATEMATİK PROGRAMLARININ ÜSTBİLİŞ BAĞLAMINDA KARŞILAŞTIRILMASI

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Bilgiye erişimin kolaylaştığı, ekonomik, teknolojik ve politik değişimlerin hızlandığı, rekabetin arttığı küreselleşen dünyada, öğrencinin kendine uygun ve yararlı bilgiyi seçebilmesi, bu bilgiye ulaşma yollarını belirleyebilmesi ve sorun durumunda uygun stratejiyi seçebilmesi için kendisi ve bilgi birikimi hakkında fikir sahibi olması gerekmektedir. Bu çalışmada Uluslararası Bakalorya Diploma Programı (UBDP) Matematik: Analiz ve Yaklaşımlar Standart Seviye ve Millî Eğitim Bakanlığı (MEB) Ortaöğretim Matematik onuncu sınıf öğretim programları üstbiliş bağlamında karşılaştırılmıştır. Bulgular, UBDP Matematik: Analiz ve Yaklaşımlar Standart Seviye öğretim programının matematik öğretimini üstbiliş ve üstbilişsel beceriler ile entegre bir formda sunduğunu, program yapısının temelde bu becerilerin gelişimini desteklediğini göstermektedir. MEB Ortaöğretim Matematik onuncu sınıf programının ise, üstbilişi kazandırılmak istenen becerilerden biri olarak ele aldığı, fakat dökümanda bununla ilgili bir kavram, bu becerileri destekleyecek bileşen veya ölçme değerlendirme yaklaşımından bahsedilmediği görülmüştür.

Anahtar Sözcükler: Üstbiliş, Uluslararası Bakalorya, Diploma Programı, Millî Eğitim Programı

ABSTRACT

A COMPARISON OF INTERNATIONAL BACCALAUREATE DIPLOMA PROGRAM (IBDP) AND MINISTRY OF NATIONAL EDUCATION PROGRAM (MoNEP) MATHEMATICS SYLLABUS IN THE CONTEXT OF METACOGNITION

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In the globalized world where access to information has become easy, economic, technological, and political changes have accelerated, and competition increased, the learner, when faced with problems, must have an idea about his/her own knowledge accumulation in order to choose the appropriate and useful information, and choose the appropriate strategy to deal with the problem.

In this study, the International Baccalaureate Diploma Programme Mathematics: Analysis and Approaches Standard Level and Ministry of National Education Secondary Mathematics tenth-grade syllabi were compared in the context of metacognition and it is aimed to answer the following three questions: a) What are the similarities and differences between IBDP and MoNEP Mathematics tenth-grade syllabi in terms of metacognition and metacognitive skills? b) How do the assessments used in the IBDP and the MoNE Secondary Mathematics syllabi differ in terms of metacognition and metacognitive skills? c) What is the support given to teachers in terms of developing metacognition in IBDP and MoNE Secondary Education Mathematics syllabi? After identification the research problems, appropriate documents, codes, sub-themes, and themes were determined by analyzing the documents.

The findings indicate that the IBDP Maths: AA SL curriculum presents mathematics teaching in a way that integrates metacognition and metacognitive skills and supports these skills with components and assessment approaches such as Learner Profile, Theory

of Knowledge, Creativity, Activity and Service, Extended Essay, Internal Assessment. However, it was observed that the MoNE Secondary Mathematics tenth-grade syllabus addresses metacognition as one of the skills to be acquired, but no concept, component, or assessment and evaluation approach to support these skills were mentioned in the document. The findings also indicate that the IBDP Mathematics: AA SL syllabus provides teachers with resources to support metacognition in terms of inquiry, critical thinking, reflection, and checking prior learning. In the MoNE Secondary Mathematics tenth-grade syllabus, there is no resource or instruction for teachers in this context.

Keywords: Metacognition, International Baccalaureate Diploma Program, National Education Program.

GENİŞLETİLMİŞ ÖZET

ULUSLARARASI BAKALORYA DİPLOMA PROGRAMI (UBDP) VE MİLLİ EĞİTİM BAKANLIĞI (MEB) ORTAÖĞRETİM MATEMATİK PROGRAMLARININ ÜSTBİLİŞ BAĞLAMINDA KARŞILAŞTIRILMASI

Ekonomik, teknolojik ve politik olarak değişimin hızlandığı, rekabetin ve çevreyle ilgili problemlerin arttığı, küreselleşen bu ortamda eğitim ve öğretimde yapılacak yenilikler ile öğrenenlerin bu değişime ayak uyduracak, onların öne çıkmasını sağlayacak becerileri kazanması önem arz etmektedir. Bu bağlamda ulusal ve uluslararası eğitim programlarının yeni dünyaya uygun şekilde güncellenmesi, öğretim anlayışında yeni yaklaşımları benimsemesi hem öğretmen hem öğrenci çerçevesinde destekleyici olması gerekmektedir. Bilgiye ulaşmanın teknoloji sayesinde çok kolay olduğu bu ortamda öğrenenlerin kendisi için uygun ve yararlı olan bilgiyi seçmesi, bu bilgiye ulaşacağı yolları belirlemesi, karşılaşacağı güncel problemler durumunda uygun stratejiyi seçebilmesi öğrenenin kendisi ve bilgisi hakkında fikir sahibi olması gerekliliğini ortaya koymaktadır. Bu gereklilik, uygulanacak öğretim programlarının özellikle üstbilişsel becerileri destekleyecek yapıda olmasını ihtiyaç haline getirmektedir. Bu noktada Türkiye'de ilk kez 1996 yılında Millî Eğitim Bakanlığı Talim ve Terbiye Kurulunca kabul edilmiş ve 1999-2000 öğretim yılından itibaren uygulanmaya başlamış Uluslararası Bakalorya Programı (UBDP) dikkat çekmektedir. Bilgi üreten, dijital çağa ayak uyduran, kültürlerarası anlayışa sahip, toplumsal ve küresel olaylara duyarlı, farklılıklara saygılı, iletişimi güçlü ve adil dünya vatandaşları yetiştirmeyi amaçlayan Uluslararası Bakalorya Programı (UB), 1968 yılında İsviçre'nin Cenevre kentinde kurulan Uluslararası Bakalorya Organizasyonu (UBO) tarafından sunulmaktadır.

Bu çalışmada 2019 yılında yayınlanan ve son olarak Kasım 2020'de güncellenen Uluslararası Bakalorya Diploma Programı (UBDP) Matematik Analiz ve Yaklaşımlar Standart Seviye kılavuzu ve 2018 yılında yayınlanan Millî Eğitim Bakanlığı (MEB) Ortaöğretim Matematik Programı onuncu sınıf öğretim programı kılavuzu üstbiliş bağlamında karşılaştırılmıştır. Çalışma kapsamında belirtilen şu üç soruyu cevaplamak

amaçlanmıştır. a) UBDP ile MEB Ortaöğretim Matematik öğretim programları arasında üstbiliş ve üstbilişsel beceriler açısından benzerlikler ve farklılıklar nelerdir? b) UBDP Matematik ve MEB Ortaöğretim Matematik öğretim programında kullanılan değerlendirme, üstbiliş ve üstbilişsel beceriler açısından nasıl farklılaşmaktadır? c) UBDP ve MEB Ortaöğretim Matematik öğretim programlarında üstbilişin geliştirilmesi açısından öğretmenlere verilen destekler nelerdir? Araştırma problemi ve uygun dökümanların belirlenmesinin ardından, dökümanların analizi yapılarak kodlar, alt temalar ve temalar oluşturulmuştur.

Bulgular, UBDP Matematik: Analiz ve Yaklaşımlar Standart Seviye öğretim programının matematik öğretimini üstbiliş ve üstbilişsel beceriler ile entegre bir formda sunduğunu, çekirdek bileşenleri olan Öğrenen Profili, Bilgi Kuramı, Yaratıcılık-Aktivite-Servis, Genişletilmiş Makale, İç Değerlendirme ve ölçme değerlendirme yaklaşımları ile temelde bu becerilerin gelişimini desteklediğini göstermektedir. MEB Ortaöğretim Matematik onuncu sınıf programının ise, üstbilişi kazandırılmak istenen becerilerden biri olarak ele aldığı, fakat dökümanda bununla ilgili bir kavram, bu becerileri destekleyecek bileşen veya ölçme değerlendirme yaklaşımından bahsedilmediği görülmüştür.

Ayrıca bulgular, UBDP'nin Matematik: Analiz ve Yaklaşımlar Standart Seviye kılavuzunda üstbilişi destekleyecek sorgulama, eleştirel ve kritik düşünme, yansıtma ve önceki öğrenmeleri kontrol etme bakımından öğretmenlere kaynak sunduğu görülmektedir. MEB Ortaöğretim Matematik onuncu sınıf öğretim programı kılavuzunda ise bu bağlamda öğretmenler için bir kaynak ya da yönergeye rastlanmamıştır.

TABLE OF CONTENTS

JÜRİ VE ENSTİTÜ ONAYI ii

ETİK İLKE VE KURALLARA UYUM BEYANI iii

ACKNOWLEDGMENTS iv

ÖZET v

ABSTRACT vi

GENİŞLETİLMİŞ ÖZET viii

TABLE OF CONTENTS x

LIST OF TABLES xiii

LIST OF FIGURES xv

ABBREVIATIONS xvi

1. INTRODUCTION 1

1.1 Problem 1

1.2 Purpose 4

1.3 Significance 4

1.4 Assumptions 5

1.5 Limitations 5

1.6 Definitions 5

2. CONCEPTUAL FRAMEWORK 6

2.1 Cognition 6

2.2 Metacognition 7

3. IBDP AND MoNEP 13

3. 1 International Baccalaureate Diploma Program (IBDP) 13

3.1.1 General philosophy 13

3.1.2 Content 14

3.1.2.1 Learner profile 14

3.1.2.2 Approaches to learning and approaches to teaching 18

3.1.2.3 Structure of IBDP 18

3.1.3 IBDP's focus on mathematics 21

3.1.4 Assessment of IBDP 26

3.2 Ministry of National Education Program (MoNEP) 28

3.2.1 General philosophy 28

3.2.2 Content 28

3.2.3 MoNEP's focus on mathematics 30

3.2.4 Assessment of MoNEP 31

4. METHOD 33

4.1 Research Design 33

4.2 Documents 33

4.3 Data Collection 34

4.4 Data Analysis 34

5. RESULTS AND DISCUSSION 40

5.1 Results 40

5.1.1 The similarities and differences between IBDP mathematics AA SL and MoNE secondary education mathematics syllabi in terms of metacognition 40

5.1.2 The differences of assessments used in IBDP and MoNE secondary education mathematics syllabus in terms of metacognition 53

5.1.3 The support given to teachers in terms of metacognitions in IBDP and MoNE secondary education mathematics syllabi 56

6. CONCLUSION AND RECOMMENDATIONS 59

REFERENCES 65

APPENDICES 71

APPENDIX 1 71

APPENDIX 2 72

APPENDIX 3 73

RESUME 100

LIST OF TABLES

Table 1. Polya's Problem-solving Stages and Related Questions 11

Table 2. IB Learner Profile 15

Table 3. IBDP Mathematics AA Syllabus Component..... 24

Table 4. IBDP Mathematics SL Internal Assessment Criteria..... 26

Table 5. Assessment Component of IBDP Mathematics AA SL..... 27

Table 6. MoNEP Tenth-grade Mathematics Syllabus Component..... 31

Table 7. The titles examined in IBDP Mathematics AA SL and MoNE Secondary Education Mathematics tenth-grade syllabi..... 34

Table 8. Themes and Categories indicating Metacognition in the documents of IBDP and MoNEP Mathematics Syllabi 35

Table 9. The frequencies of codes in IBDP and MoNEP Mathematics syllabi 38

Table 10. A Comparison of frequency of theme MC and MCRg in IBDP and MoNEP Syllabi 41

Table 11. The frequency of codes in Philosophy and Introduction in IBDP and MoNEP Mathematics Syllabi 42

Table 12. The frequency of themes in components of IBDP and MoNEP Mathematics Syllabi..... 52

Table 13. The frequency of themes in assessment element and criteria of IBDP and MoNEP Matematics syllabi 53

Table 14. The frequency of codes of Support for Teachers in IBDP and MoNE Mathematics syllabi 57

LIST OF FIGURES

Figure 1. Diploma Program Model 19

Figure 2. The Mathematics Model of IBDP 23

ABBREVIATIONS

MoNEP	**:**	Ministry of National Education Program
IBO	**:**	International Baccalaureate Organization
IBDP	**:**	International Baccalaureate Diploma Program
TOK	**:**	Theory of Knowledge
CAS	**:**	Creativitiy, Activity, Service
EE	**:**	Extended Essay
IA	**:**	Internal Assessment
LP	**:**	Learner Profile
f	**:**	Frequency

1. INTRODUCTION

1.1 Problem

In recent years, the development of technology, along with the rapid changes in communication channels, the understanding of globalization and the competitive environment in globalized economic conditions, and the need for better equipped human resources have caused to differentiate in the abilities that individuals need to survive and be successful. It is only possible for individuals and countries to keep up with this change through education. For this purpose, both national and international education programs should be organized in a way to develop individuals' abilities such as analytical perspective, problem-solving, digital competence, critical thinking, awareness of their own learning, literacy, intercultural communication, global awareness and sensitivity.

The International Baccalaureate Program (IB), of the International Baccalaureate Organization (IBO), which was established in Geneva, Switzerland in 1968, aims to raise global citizens who produce knowledge, keep up with the digital age, have an intercultural understanding, are sensitive to social and global events, respect differences, have a strong communication, and are fair. It offers four international education programs (Primary Years Program (PYP)/ Middle Years Program (MYP) / Diploma Program (DP)/ Career-related Program (CP)) for the K-12 age ranges (IBO, 2019).

The word learner instead of student is used in the IB Program to show that learning is not only limited to students, but encompasses the staff and the parents as well. This reveals their learner-centered approach. McClaskey (2018) says, “Learners can learn without teachers, but students are only students when they have teachers.” With this philosophy, IB Programs are designed with a focus on learning rather than teaching. They employ a constructivist approach that focuses on how students learn with teachers as facilitators and guides of learning. In her study, Güneş (2010) explains the constructivist approach as “raising individuals who research information, know where and how to use it, have knowledge about their own learning style, associate the new information they have

learned with their past experiences, and at the same time produce new information and find solutions to the problems they encounter" (Güneş, 2010). Similarly Perkins (1999), point out that -learners using the constructivist approach are those who are conscious of own learning, re-create the knowledge for themselves, organize what they have learned, and discover knowledge with the guiding role of teachers (Perkins, 1999). The skill of knowing about one's own learning', which is expressed in the definitions of constructivist approach, corresponds to the concept of metacognition introduced by John H. Flavell in the 1970s. In short, metacognition means being conscious of one's own thinking processes and being able to manage and configure these processes. In Flavell's (1976) studies, it is seen that the concept of metacognition is considered as two components: metacognitive skills and metacognitive knowledge. Metacognitive knowledge is the individual's knowledge of what kind of process her cognitive processes follow (Flavell, 1979). Metacognitive skills are defined as the skills of finding out what information is necessary for oneself, making a plan for it, determining and interpreting the strategy needed in the problem-solving process, being aware of the strategies used and thinking deeply about their performance, and using the evaluation processes effectively (Costa, 1984).

Since metacognitive skills mean mental actions and awareness of these actions, the development of these skills directly affects problem-solving skills. When learners encounter a problem, they need to apply the steps of understanding what this problem is, thinking about possible solutions for problem-solving, determining the appropriate strategy, applying it, and checking and evaluating the result. All of these mental actions define metacognitive skills (Costa, 1984).

Problem-solving is the process of recognizing the problem, searching for its source, searching for a solution, finding the appropriate solution and applying this solution in case of a problem.

The problem-solving process is especially at the center of mathematics courses. In these areas, structuring the program in such a way that students take active role in learning, experience problem-solving stages, and receive feedback makes them more successful. H. Lee Swanson (1990) concluded in his study that students with higher metacognition level had higher problem-solving performance (Swanson, 1990). Hence, it is important

for instructors to prepare an environment that will reveal learners' metacognitive skills and provide them with the opportunity to use these skills.

One of the goals of the progam implemented by the Ministry of National Education (MoNE), which is the provider of education services in Turkey, is to raise entrepreneurial individuals who are skilled and knowledgeable, aware of national and universal values, aware of their responsibilities and rights, able to communicate and cooperate. Another aim is to provide an environment and opportunity for students to develop their thinking, understanding, research and problem-solving skills through curricula (MoNE, 2018).

In the 2004-2005 education period, the MoNE Primary Education Program was updated in accordance with the student-centered and constructivist approach, and it was expressed that that the developed program is planned in a way that encourages children to learn to learn and to think and ask questions by making connections with their environment during the learning process. (İlhan & Aslaner, 2019). The metacognitive skills implicitly expressed here show that the constructivist approach is used. In the primary school mathematics program published by the Ministry of National Education in 2018, it is seen that the objectives of "developing students' metacognitive knowledge and skills, enabling them to have the awareness to manage their own learning processes and gaining skills to follow the problem-solving processes" are included in the syllabus (MoNE, 2018).

2018 MoNE Secondary Education Mathematics guide include the statement "a holistic syllabus that encourages the use of metacognitive skills, provides meaningful and permanent learning, is associated with previous learning, and is associated with different disciplines and daily life within the framework of values, skills and competencies" (MoNE, 2018). Based on these expressions; it is seen that MoNEP adopts a constructivist approach that includes metacognitive skills.

In this study, syllabus, assessment and evaluation approaches, the approaches learning and teaching, and teacher support materials of the Ministry of National Education Program (MoNEP) and the International Baccalaureate Diploma Program (IBDP) will be examined in the context of metacognition.

1.2 Purpose

The main goal of this research is to compare the learning and teaching approaches in mathematics courses of the International Baccalaureate Diploma Program and the Ministry of National Education Program with document analysis method and reporting the results in the context of skills, to reveal their similarities and differences.

This study aims to answer the following questions:

1. What are the similarities and differences between IBDP and MoNEP Mathematics syllabi in terms of metacognition and metacognitive skills?

2. How do the assessments used in the IBDP Mathematics and the MoNE Secondary Mathematics syllabi differ in terms of metacognition and metacognitive skills?

3. What is the support given to teachers in terms of developing metacognition in IBDP and MoNE Secondary Education Mathematics syllabi?

1.3 Significance

In the literature, there are some studies on the problem solving and metacognition skills of secondary school students and teachers and the metacognition skills of students in IBDP (Çınar, Hatunoğlu, & Hatunoğlu, 2009); (Karslı, 2019); (Kaya & Kırbaç, 2019); (Midilli, 2020); (Dulun, 2018). However, a comparative study of IBDP and MoNEP in the context of problem solving and metacognitive skills has not been found.

The development of metacognitive skills of learners in the globalizing world will support them to become individuals who are successful, creative, sensitive and respectful, who keep up with developments, question extensively, think thoroughly, and take calculated risks.

The skills to be examined through this research can shed light onto the practices of teachers and learners; it can give an idea for teachers to restructure their teaching content and environments.

1.4 Assumptions

In this research, it is assumed that the mathematics syllabi of IBDP and MoNEP curricula and the master's and doctoral theses on metacognition in the National Thesis Center of the Council of Higher Education could represent the relevant studies on the subject.

1.5 Limitations

This research is limited to the International Baccalaureate Diploma Program (IBDP) Mathematics Analysis and Approaches (AA) Standard Level (SL) guide published in 2019 and last updated in November 2020 (IBO, 2021) and the Ministry of National Education Secondary Education Mathematics Program tenth-grade syllabus published in 2018 (MoNE, 2018).

1.6 Definitions

IB Learner Profile: identifies a wide range of human responsibilities and capabilities beyond academic achievement (IBO, 2017).

Theory of knowledge (TOK): TOK gives the opportunity to inquire and discuss about knowledge and knowing process (IBO, 2022).

Creativity, Activity, Service (CAS): CAS gives students the chance to gain experience and take action in addition to academic studies (IBO, 2017).

Curriculum: A broad and comprehensive education and training program that covers more than one subject or field of study, intellectual, cognitive, linguistic and scientific resources, outlining aims, objectives, content, teaching methods, assessments, and general educational experiences (Woods, Luke, & Weir, 2010).

Syllabus: It provides detailed information about a course in the curriculum, such as learning objectives, topics to be covered, required readings or materials, assignments, grading criteria, etc., which serve to shape the parameters of the curriculum within a specific time and place (Woods, Luke, & Weir, 2010).

2. CONCEPTUAL FRAMEWORK

2.1 Cognition

In order to explain metacognition and its components well, it would be more meaningful to first examine what cognition is and then its differences and similarities with metacognition.

Cognition is defined as processes involving mental actions such as knowing, recognizing, understanding, comprehending, reasoning, and problem-solving, aimed at understanding the world and the environment (Cherry, 2023). Yaycı (2005) has added “intelligence, concept formation, language acquisition and creativity” to these actions (Yaycı, 2005); Kandır has added "knowledge, attention and decision making" (Kandır, 2005). Mental processes such as perceiving the environment, interacting with the environment, paying attention to something, coding and storing information, using language, symbols and sounds to express feelings and thoughts, acquiring knowledge and skills, deciding on the appropriate solution from existing knowledge and experiences when a problem is encountered, are the basic structures of cognition. Cognition, in its shortest definition, can be defined as the adventure of understanding the universe.

Looking at the historical development of cognition, we see that it goes back to ancient Greek philosophers such as Aristotle and Plato. Plato's questions about the knowledge nature and how we learn have laid the groundwork for later studies. It is known that Aristotle worked in many areas, including how the mind affects human experience and the workings of the mind. The words "cognition" and "cogito" have the same root, which is one of the forms of the Latin verb "to know", and it is claimed that the closest scientific synonym of the word "cognition" is "to think" (Andrade & Walker, 2023). This brings to mind the proposition "I think, therefore I am" in Descartes' book "Discourses on Method" written in 1637. Descartes determined four rules to reach knowledge by using a self-centered, distrustful, skeptical approach. The first rule is not to accept anything that one does not know clearly and distinctly to be true; the second rule is to break down the problem encountered or the thing to be studied into small parts; the third rule, is from small parts to complex structures, that is, induction; the fourth rule is to control operations

at every step taken. Based on the definitions of cognition, Descartes' four-stage method expresses the necessity of using mental processes to achieve knowledge (Yolcu, 2016).

In the 19th century, Wilhelm Wundt, who is known as one of the pioneers of modern psychology tried to examine the introspection method, which asks what the individual thinks and how he feels, in a controlled laboratory environment in terms of psychology. More clearly, he argued that psychology should focus on analysis of the content of one's own mind and experience or introspection, and became one of the most important figures in cognition (Schunk, 2012).

In the 20th century, John B. Watson, Burrhus F. Skinner, and Jean Piaget are known for their work on cognition. Watson argued that the introspection method he used himself was not reliable, that working on concepts such as consciousness and mind is contradictory and difficult, and psychological phenomena can be detected without these concepts. Watson examined mental processes and behaviors in his studies on animals based on psychology B. F. Skinner, whose views are widely accepted in the field of psychotherapy, contributed to the development of learning theories. (Senemoğlu, 2020). As a result of his experiments on learning and behavior with dogs, mice, pigeons, monkeys and children, he drew attention to the similarity of learning processes despite biological differences. While working on children at the university, Jean Piaget noticed that the answers given by children of different ages differ in terms of age, intelligence and quality. Thereupon, he tried to explain the scientific processes that caused these differences (Senemoğlu, 2020).

Cognition, which has been studied for nearly two thousand years, is still being studied by researchers from various fields such as genetics, psychology, education, neuroscience, linguistics and artificial intelligence.

2.2 Metacognition

John H. Flavell, who first used the word metamemory in his work in 1976, brought the word metacognition to the literature after he developed his studies in 1979. According to Flavell (1979) metacognition is awareness of one's learning style, awareness of when one understands and when one does not; knowledge of how to use previous knowledge and experience to achieve the goal; choosing the appropriate strategy in case of a problem;

defines it as making an evaluation of one’s own performance (Hartman H. J., 2002). Though there are many distinct definitions of metacognition in the literature such as: "learning to learn", "thinking about thinking", "awareness of one's own learning", "cognition about cognition", almost all these definitions are related to awareness of what one knows, how one learns, and the process of learning and evaluation.

According to Brown (1987), metacognition refers to higher-order thinking that includes awareness and control of cognitive experiences related to learning. In another definition, metacognition is the individual's awareness of his own cognition and learning characteristics (Gagne & Berliner, 1988; Klausmeier, 1985; cited from Senemoğlu Nuray, 2020).

According to Sternberg (1988), metacognition is defined as a high level administrative process in which evaluation, planning, and monitoring are used in solving an individual's problem (cited from Özsoy Gökhan, 2008).

In the method of introspection put forward by John B. Watson and the psychologists who first called it cognition, it is clear that this method actually represents metacognitive processes, since the person questions himself objectively while seeking answers to psychological questions.

According to John Locke, who is interested in cognitive functions, the mind acquires knowledge through experiences. Locke recognized that there are two different experiences that come from sensation and reflection. Here he used the term "reflection" to mean "the ideas that the mind derives by reflecting on the operations within itself" (Locke, 1999).

In his study, Flavell (1979) divided the cognitive monitoring model into four elements: *metacognitive knowledge*, *metacognitive experiences*, *goals (or tasks),* and *actions (or strategies)* (Flavell, 1979, s. 906) Definitions are given belows (Flavell, 1979).

> Metacognitive knowledge is that part of your (a child's, an adult's) stored world knowledge that has to do with people as cognitive creatures and with their diverse cognitive tasks, goals, actions, and experiences.

> Metacognitive experiences are any conscious cognitive or emotional experiences that accompany and pertain to any intellectual enterprise.
>
> Goals (or tasks) refer to the objectives of a cognitive enterprise.
>
> Actions (or strategies) refer to the cognitions or other behaviors employed to achieve them (s. 906-907).

Metacognition consists of two components: cognition knowledge (metacognitive knowledge) and regulation of cognition (metacognitive control, metacognitive strategies).

Cognitive knowledge is generally defined as knowledge about cognition or awareness of cognitive activities. Cognitive knowledge is classified as conditional knowledge, declarative knowledge, procedural knowledge. *Declarative knowledge* is information about “things” and includes information about oneself as a learner and about factors that influence performance. *Procedural knowledge* is information of "how" to do something. It is represented by heuristics or strategies. The more procedural knowledge, the better the task is performed. Broad strategy knowledge enables the person to rank the strategies in a problem situation and to use the appropriate strategy for the situation. *Conditional knowledge* is expressed as knowing the "how" and "when" aspects of cognition (Brown A. L., 1987; Janis E. Jacobs, 1987; Gregory Schraw, 1995 cited from (Hartman, 2002)).

In order to explain this structure in more detail, Flavell (1979) also identified three variables that affect metacognitive knowledge:

> Person Variables: This includes individual knowledge and beliefs about himself and others as a learner. For example, his social awkwardness may be noticed compared to his friend, who is considered to be more crowd-pleasing.
> Task Variables: This contains all the information a person has about a proposed task. This information serves as a kind of guidance in managing the task and predicting the success of the task. For example, awareness of one's swimming ability helps one decide how deep in the sea to go or not.

> Strategy Variables: In the case of problem solving or performing a task, the strategy aspect of metacognitive knowledge includes setting goals and sub-goals and identifying strategies and methods to achieve these set goals (s. 907).

Regulation of cognition (metacognitive control) includes activities such as planning, monitoring and evaluating cognitive processes and products (Baker & Brown, 1980); (Hartman, 2002). Being able to regulate and control metacognition enables learners to use the information in accordance with the situations (Özsoy, 2008). Metacognitive regulation promotes performance, better use of resources and strategies, and awareness of what the learner does and does not know (Hartman, 2002). The literature focuses on four regulatory skills: planning, monitoring, prediction and evaluation (Deseote and Roeyers, 2002; Schraw and Moshman, 1995; Deseote, Roeyers, Buysee, 2001; Lucangeli and Cornoldi, 1997 cited from Özsoy Gökhan, 2008).

Prediction involves the learner estimating the goals, how long the learning process will take, and the probability of outcomes.

Planning is defined as the skill to identify what is needed, choose the appropriate strategy and allocate resources.

Monitoring is the skill to comprehension and recognize task performance. Tests for monitoring can be developed.

Evaluation is the ability to evaluate one's learning products, goals, and productivity.

According to Flavell (1979), metacognitive experiences can enable learners to set new goals, revise their previous goals, or abandon their goals. Likewise, metacognitive experiences have the effect of deleting and revising the metacognitive knowledge base. For clarity, Flavell (1979) exemplifies these two situations as follows:

> For example, thinking that you don't know a part of the text you're reading well enough to pass the exam tomorrow is a metacognitive experience. For this reason, re-reading can be explained as a goal-oriented cognitive strategy. As a sample of the latter; it is a metacognitive experience to wonder if you understand a part of the text you read well enough to pass the exam. For this reason, asking yourself questions and trying to know by noticing how well you know can be

expressed as a metacognitive strategy in the form of evaluating information and creating another metacognitive experience (p. 908-909).

Problem solving is an important element in metacognition as will be explained below. It is a thinking process in which individuals strive to solve the difficulties and problems they face in daily life. Problem solving skills can be defined as the skill to grasp the problem, analyze it, determine appropriate strategies for solving it, decide on the appropriate strategy, and implement and evaluate it. Since problem-solving is a complex process, dividing this process into stages from a reductionist perspective facilitates the problem solving process. At this point, George Polya brought a new perspective to the problem-solving process with his book "How to Solve It?" was published in 1945. In this book, which is stated to have started a new era in the teaching of problem-solving, Polya split into the problem-solving process into four phases (Conway, 1973).

Polya's problem-solving phases and the questions that can be asked for the implementation of these phases are given in the Table 1 (Conway, 1973).

Table 1. Polya's Problem-solving Stages and Related Questions (Conway, 1973).

Phases	**Explanation**	**Questions**
1. Understanding the problem	In order for a situation to be well understood, its verbal expression must first be understood. It is recommended to use methods such as summarizing, taking notes, drawing figures or graphs to grasp the problem.	What is unknown? What are data? What is the situation?
2. Develop a plan	This is the process of identifying possible solutions and their pros and cons and deciding on the appropriate one.	Have you solved such a problem before? Can you use the methods you learned before? Go back definitions.

3. Carrying out the plan	The solution planned in the previous step is implemented and the result is achieved.	Can you agree clearly that the step is correct? Can you demonstrate that it is correct?
4. Looking back	It is the process of testing the answer to the problem, re-analyzing it if it is wrong and identifying the deficiencies. Recognizing one's mistakes in the process and seeking solutions to correct them refers to metacognitive skills (Conway, 1973).	Can you control the result? Can you reach the result in a different way? Can you adapt the result, or method, for some other problem?

When Polya's problem-solving stages and the questions to be asked to solve the problem are analyzed, it is seen that these stages coincide with the planning, monitoring, controlling and evaluating processes in metacognition (Ader, 2019) and that the questions are of a quality that will provide perspectives to develop metacognitive skills.

3. IBDP AND MoNEP

In this section, general description about the International Baccalaureate Diploma Program (IBDP) and the Ministry of National Education (MoNEP) Secondary Education Program will be given.

3. 1 International Baccalaureate Diploma Program (IBDP)

3.1.1 General philosophy

When the general philosophy of the International Baccalaureate is examined in terms of the skills it aims to develop in students, it is seen that it aims to raise inquiring, knowledgeable and sensitive young people who help build more peaceful and a better world through respect and intercultural understanding (IBO, 2019). Related to our focus theme, one of the first goals of the program is to bring up “knowledgeable” people, who discover and use knowledge and are aware of their learning needs shows that emphasis on skills that will develop individuals’ metacognitive and problem-solving skills.

The philosophy goes on to explain that they are working to attain high quality international and assessment programs worldwide in the second sentence of the philosophy. “To this end, the organization works with schools, governments and international organizations to develop quality international education and assessment programs” (IBO, 2021).

In the third and last sentence of the General Philosophy: “These programs encourage students around the world to become active, compassionate, lifelong learners who understand that other people, despite their differences, can also be right (IBO, 2021)”, it is clear that they will strive for creating the “lifelong learner”.

3.1.2 Content

The Diploma Program carried out by the IB organization is a two-year intensive international program designed for students between the ages of 16-19, preparing them for their future lives before university and encouraging them to be knowledgeable, sensitive and skilled. This program focuses specifically on the development of students in the context of intercultural understanding, open-mindedness, and respect for and appreciation of diverse perspectives (IBO, 2017).

When we examine the IBDP Mathematics Analysis and Approaches syllabus, we see that its aim to ensure that they become individuals who can follow developments in a changing world, solve problems and are equipped with skills is to educate students for the future. This is also the origin of this research. Ensuring this development in individuals is about being able to include them in the teaching period. In this respect, the structure of the syllabus is important.

It can be seen that the philosophy, structure, content and pedagogy of the IB Diploma Program, which was developed in 1962, was inspired by the pedagogical perspectives of leading names in the world of education such as Alec Peterson, John Goormaghtigh, Kurt Hahn and Robert Leach. These visionary leaders planted the seed of the futuristic education curriculum that has effected and continues to do so both international and national education programs since IBDP's inception more than half a century ago. IBDP was structured as a syllabus that is vastly in contrast with the properties of the traditional curriculum in many respects (IBO, 2019).

3.1.2.1 Learner profile

The IB program aims to provide students with ten basic attitudes that will enable them to keep up with the developments in today's world and be adaptive and versatile, while encouraging them to be aware of national and international values and ethics, as well as academic success. These ten basic attitudes serve as a guide for teachers, educational practitioners, and students and emphasize the importance of moving beyond the traditional educational perspective. These ten basic attitudes are given in Table 2 (IBO, 2021).

In analyzing the Learner Profile (LP) in the last column I would like to highlight some words and phrases in each LP trait explanation that has a direct relationship with metacognitive learning (IBO, 2021).

Table 2. IB Learner Profile (IBO, 2021)

Trait	Explanation	Indication of Metacognitive Learning
Inquirers	It refers to attitudes of curiosity, developing inquiry and investigation skills, and knowing how to learn both alone and with others (IBO, 2021).	Inquiring Knowing how to learn Curiosity
Thinkers	It refers to the attitudes of using critical and creative thinking skills to solve problems and analyze and taking initiative to make logical and ethical decisions (IBO, 2021).	Thinking to analyze Taking responsible action for complex problem
Knowledgeable	It refers to the attitudes of developing and using exploring knowledge and conceptual understanding, in different disciplines, and being sensitive to issues and ideas of local and global importance (IBO, 2021).	Exploring knowledge Developing and using conceptual understanding
Communicators	"It refers to the attitudes of expressing oneself safely and imaginatively in more than a language and in many ways,	Expressing ourselves Collaborating Listening to the other perspectives

	cooperating, taking into account different points of view (IBO, 2021).	
Principled	It refers to attitudes of acting with honesty and integrity, a strong sense of justice and equity and respect for the dignity and rights of people everywhere, and taking responsibility for actions and their consequences (IBO, 2021).	Taking responsibility Deciding with a sense of justice and fairness
Open-minded	It refers to attitudes of critical appreciation of our own cultures and personal history as well as the traditions and values of others, willingness to grow from our experiences, seeking and evaluating perspectives (IBO, 2021).	Evaluating and researching and a range of points of view
Caring	It refers to attitudes of empathy, compassion, respect, a sense of service and acting to contribute to the world (IBO, 2021).	Showing empathy
Risk-Takers	It refers to the attitudes of approaching uncertainty with foresight and determination; working independently and collaboratively to discover innovative strategies and new	Forethought Exploring new ideas and strategies Working independently

	ideas; and being resourceful and resilient in the face of difficulties and change (IBO, 2021).	
Balanced	It refers to attitudes of understanding the importance of balancing the intellectual, physical and emotional aspects of our lives to ensure the well-being of ourselves and others, and to be aware of interdependence with other people and the world in which we live (IBO, 2021).	Recognizing our interdependence intellectual
Reflective	It refers to the attitudes of thoughtfully evaluating the world and our own ideas and experiences, and identifying our weaknesses and strengths to support learning and personal improvement (IBO, 2021).	Considering our own experience and perception Strive to understand

Metacognitive skills such as being aware of one's own learning process, knowing and using strategies on how to manage this process, monitoring, being sensitive to local and global problems and taking action for them depend on the development of skills such as *being knowledgeable, being intellectual, being sensitive, empathizing, analyzing, predicting and reflecting.* When the IB Learner Profile is examined, it is seen that it emphasizes all these skills that will contribute to metacognitive skills.

3.1.2.2 Approaches to learning and approaches to teaching

Approaches to Learning (ATL) are defined as the abilities that learners need to improve to be qualified learners. These skills are examined in five groups: *thinking, communication, social, self-management* and *research skills* (IBO, 2021).

Approaches to Teaching (ATT) refer to the pedagogical principles and instructional strategies that teachers and educational practitioners use to facilitate student learning. These pedagogical principles and strategies are presented under six basic headings. Teaching in IB programs (IBO, 2021):

-Focused on conceptual understanding

-Differentiated to meet the needs of all learners

-Focused on effective teamwork and collaboration

-Enlightened by assessment (summative and formative)

-Developed in local and global contexts

-Based on inquiry.

3.1.2.3 Structure of IBDP

The IB Curriculum is represented in the form of an *onion diagram* indicating its structurally important elements. Three profiles, represented at the very center sare that of the student, teacher, and parent, which symbolized that they are actually all learners. Then in the second ring the pedagogical approaches of the IB are given seperated into two parts as Teaching and Learning Approaches.

The next ring shows TOK, EE, CAS, which are defined as the core components in many descriptions. These are encircled by the six academic areas, which are Mathematics, Sciences, The Arts, Studies in Language and Literature, Individuals and Societies, and Language Acquisition that assures the balanced structure of the program.

The students must take one course from each of these diciplines for the balanced versatility of their learning. Limitation to six areas or disciplines also assures that students are not overloaded in their academic studies to leave time and space for a balanced life to develop them more holistically.

This IBDP Curriculum framework is given in Figure 1 (IBO, 2021)



Figure 1. Diploma Program Model (IBO, 2021)

TOK, CAS and Extended Essay components forming the core of the model must be completed by DP students in addition to passing the six academic courses they have taken to graduate from the program.

Theory of Knowledge (TOK)

Theory of knowledge (TOK) inquiries about information and the process of knowing. TOK emphasizes comparisons and connections between fields of knowledge and empowers students to acquire a greater cognizance of their own view and the views of others (IBO, 2022).

Theory of Knowledge (TOK) is essentially a course concerned with inquiry and critical thinking towards the process of knowing rather than the acquisition of specific knowledge.

In the TOK lesson, students are encouraged to question how information in different fields is accessed and how information is known, and to discover and analyze the connections between different fields.

During the course, twelve concepts are emphasized in order to examine their relationship with knowledge: *evidence, certainty, truth, interpretation, power, justification, explanation, objectivity, perspective, culture, values* and *responsibility* (IBO, 2022, s. 6). It is one of the most important elements of the DP that schools must allocate at least 100 hours of teaching time.

The TOK curriculum consists of three parts that are deeply interconnected (IBO, 2022).

> Core theme- The knower and knowledge: This theme ensures an chance for students to reflect on and critize themselves as knowers and thinkers, and on the different communities of knowers to which we belong.
>
> Optional theme: This element provides an opportunity to look in more depth at two themes of particular interest to teachers and students.
>
> Areas of knowledge (AOK): This area is particular branches of knowledge, each of which can be viewed as having a different nature and sometimes using different methods to acquire knowledge (s. 5).

Guidance and suggested knowledge questions are provided to guide teachers and students in exploring these three parts of the TOK syllabus.

These proposed knowledge questions are organized within a context of four elements: methods and tools, scope, perspectives and ethics: This "knowledge framework" encourages in-depth exploration of each theme and the TOK and encourages students to make interdisciplinary connections.

TOK has two tasks in the evaluation process (IBO, 2022):

> The TOK exhibition assesses the student's skill in showing how TOK is manifested in the world around us. The exhibition is an internal assessment component; it is marked by the IBDP teachers and externally moderated by the IB.
>
> The TOK essay is an essay in which the topic is discussed in response to a topic focusing on students' areas of knowledge. The essay is an external assessment component and is assessed by IB-authorized officials (s. 5).

Creativity, Activity, Service (CAS)

Creativity, activity, service (CAS) supplies learners with the chance to engage in new experiences alongside their academic studies. It is a journey in which students take action in collaboration, exhibit the characteristics of the IB Learner Profile, and have the opportunity to discover themselves and others. CAS is organized around the three strands of creativity, activity and service defined as follows (IBO, 2017):

> Creativity is the innovation or discovery of a product or performance by interpreting it from a new or original perspective.
>
> Activity is physical exercise and actions that promotes a healthy habits.
>
> Service is reciprocal and collaborative interaction with society in response to a real need (s. 18-20).

Completion of the CAS is based on the student's achievement in the seven CAS learning outcomes. Besides that, students must create a portfolio in which they write about their experiences and thoughts throughout the CAS process. This portfolio is not officially evaluated (IBO, 2017).

Extended Essay (EE): The Extended Essay (EE) is a long essay that students write to explore a topic of interest, either from a course chosen from among the six DP courses or from an interdisciplinary approach. The EE supports students to develop the self-regulated planning, writing and research abilities they will need in furture educational lives (IBO, 2023). The EE is supported by a supervision process in which students discuss in-depth with their teachers. During this process, students have the chance to collect information from sources, analyze and synthesize data, discover interdisciplinary connections, develop reflection, time management, etc. (IBO, 2023).

3.1.3 IBDP’s focus on mathematics

In order for individuals to sustain oneself in a new world and to keep up with developments, curricula require arranged in a way that motivates them to acquire knowledge and skills. Considering today's needs, it is important that students become

individuals who think critically, know how to approach a problem and take action. At this point, mathematics courses that provide space for these skills are of critical importance.

The IBDP Mathematics program is presented as a language for learners to explore, understand, communicate, count objects, and measure the world they live in, and as an exploration for interdisciplinary analysis, prediction, risk-taking, and probability calculation. Acting with abstract concepts and generalizations, mathematical understanding is developed by going deeper and connecting ideas. These language and discovery aspects of mathematics allow mathematics to be approached from different perspectives, although they are interconnected with the same mathematical understanding, perspectives of thinking and ways of handling problems. In this respect, the Diploma Program offers two different programs: Analysis and Approaches (AA) and Applications and Interpretation (AI). Each of these programs has Standard Level (SL) and Higher Level (HL) (IBO, 2021).

In order for students to determine which program and which level of course is right for them, they need to consider the following points:

-The type of mathematics they can succeed in and what their own skills are,

-The topic that might interest them the most their interest in mathematics and what the topic of interest is

-Other course selections within the DP or Career Related Program (CP)

-Academic plans and career choices

-Advice from teachers

Analysis and Approaches (AA): Suitable for students who are able and enjoy studying mathematics on their own and who want to develop strong skills in mathematical thinking. In this lesson, students will have the chance to discovery mathematical ideas with and without technology, study theories, solve problems, and generalize. At the SL, students should have interest in patterns, mathematical generalization of patterns, and algebraic expressions. At the HL, students should have strong algebraic skills, be able to understand and do proofs, and enjoy solving challenging problems (IBO, 2021).

Applications and Interpretation (AI): The focal point of AI is on the application of mathematical modeling, the use of mathematics in daily life and problem solving to interdisciplinary work. The applicability of mathematics and technology to various fields is emphasized. For the SL of the course, students should have an interest in the use of mathematics to solve real-world problems. At the HL of the course, the focus is on students' strong algebraic skills and their ability to solve challenging real-world problems comfortably using technology (IBO, 2021).

This study will examine the IBDP Mathematics Analysis and Approaches syllabus which is the one used generally in the IB schools in our country because it is more compatible with MoNEP. The IBDP Mathematics Analysis and Approaches (AA) program model is given in Figure 2 (IBO, 2021).

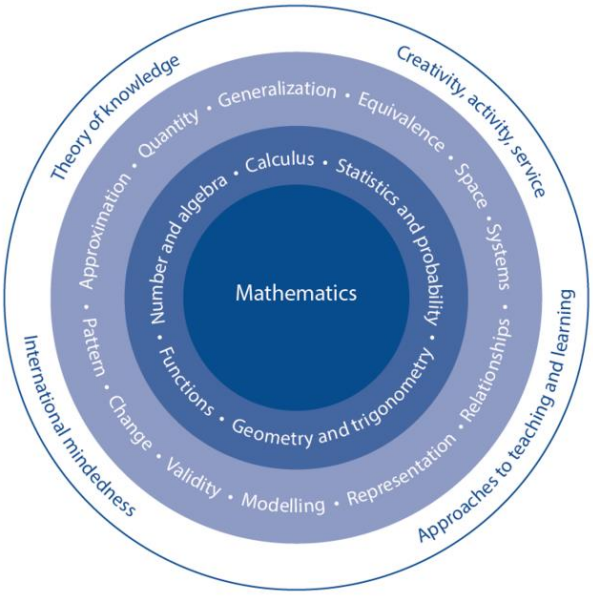


Figure 2. The Mathematics Model of IBDP

The following are important components of the course, and they will be defined below and will be analyzed in more detail in the discussion part in the context of metacognition and metacognition skills and its relationship to the course, i.e. Mathematics Analysis and Approaches. For example, Mathematics and TOK course encourages students to question, explore and reflect on assumptions about mathematical knowledge (IBO, 2021).

As for the relationship of Mathematics and CAS, evaluate Mathematical understanding supplies an important to understanding the world we live in. The mathematical skills and

techniques that students learn in mathematics lessons will help them develop, plan, and share CAS experiences or projects, allowing them to the world around them.

A very important goal of IB programs is International-mindedness (IM). The global exchange of mathematical knowledge and ideas from the past to the present has enabled the advancement of mathematics. With this component of the course, it is encouraged to recognize the influence of mathematics in the cultural and international dimensions of trade, historical events, politics and science and to gain an international perspective (IBO, 2021). The IBDP Mathematics AA Syllabus Component is given in Table 3 (IBO, 2021).

Table 3. IBDP Mathematics AA Syllabus Component (IBO, 2021)

Syllabus Component	**Suggested Teaching Hours**	
	SL	**HL**
Topic 1- Number and Algebra	19	39
Topic 2- Functions	21	32
Topic 3- Geometry and Trigonometry	25	51
Topic 4- Statistics and Probability	27	33
Topic 5- Calculus	28	55
The toolkit and Mathematical Exploration	30	30
Total Teaching Hours	150	240

When the IBDP Mathematics AA syllabus is examined, it is seen that it has on five approaches to teaching and learning such as: *Conceptual understanding*, *Mathematical inquiry, Mathematical modelling*, *Proof* and *Use of technology*.
Conceptual understanding in Mathematics is important for inquiring about topics and ideas, organizing knowledge and exploring the essence of mathematics, and concepts are used in problem solving, analyzing knowledge and problems, and evaluating.

In the IBDP Mathematics courses, concepts are key to fostering deep learning, and the development of a balanced, broad and holistic curriculum (IBO, 2021). The course identifies the following twelve key concepts such as approximation, validity, modelling, change that relate to each of the five subjects with different emphases (IBO, 2021). Understanding the concepts facilitates the problem-solving process as it stages the

problem-solving process in terms of discovering a pattern, making inferences, determining the appropriate table, graph or formula that can represent a problem, performing operations, predicting the possible results of the problem, and inquiring.

Mathematical Inquiry promotes the learning of strategies, skills and attitudes that encourage students to experiment, question, explore and think critically (IBO, 2021).

Another skill is Mathematical modeling that plays an important role in students' problem solving or handling of a situation in almost every field. Mathematical modeling is the representation of real-life situations with mathematical tools such as patterns, concepts, formulas, etc. (IBO, 2021)

Mathematical modeling is an important tool that can be included in the problem-solving process and improves problem-solving skills. First of all, the problem is defined with the skills of making observations, noticing changes and making inquiries. After defining the problem, an appropriate mathematical representation is selected by hypothesizing about the situation and this representation is tested to see if the results are correct. As a result of the test, the model is made functional by revising the model and checking the missing/incorrect steps and the model is used for explaining the situation, making decisions, etc. Since all these steps involve monitoring, decision-making, critical reflection, critical thinking and evaluation processes, mathematical modeling also encourages metacognitive skills.

Proof is important in providing a deeper understanding of mathematical concepts. The process of proving the existence or non-existence of a hypothetical situation by combining knowledge with logical steps requires cognitive processes. In this respect, the mathematics program is structured in a way that encourages students to make proofs (IBO, 2021).

The development of technology also affects the content of mathematics courses. The use of technology in mathematics is encouraged in terms of concretization, applying information and formulas in a more practical and understandable way, and eliminating misconceptions. Graphing calculators, graphing and geometry software, simulations and applications are used in DP Mathematics courses (IBO, 2021). In the IBDP Mathematics

course, the use of technology is allowed in some of the common written exams administered at the end of two semesters. It will be detailed in the 3.1.7 Assessment section.

3.1.4 Assessment of IBDP

IBDP program gives high importance to monitoring students' progress in assessment processes, giving feedback to students about their weaknesses and strengths, and making formative assessments in terms of learning styles. The assessment process is divided into two as: *internal assessment* and *external assessment* (IBO, 2019).

Internal assessment (IA) is research conducted by students regarding a problem related to a field they are interested in and its solution. During this study process, teachers provide feedback to the students as facilitators and guides, and the evaluation is made by the teachers and externally moderated by the IB. Students are required to complete research studies called Internal Assessment (IA) in order to graduate from the program. In the Internal Assessment (IA) evaluation process, students' research is evaluated based on five criteria: *Presentation, Mathematical communication, Personal engagement, Reflection, Use of mathematics*. In the Internal Assessment evaluating process, the teacher grades each criterion according to the level of presence of the descriptors in the research. Assessment criteria, achievement level and key words to determine the criteria are given in the Table 4 (IBO, 2021). Additionally, the IBDP Mathematics AA SL assessment component is given in Table 5 (IBO, 2021).

Table 4. IBDP Mathematics SL Internal Assessment Criteria (IBO, 2021)

Criteria	**Achievement Level**	**Descriptors of Level**
Criterion A Presentation	0-4	Coherent Well-organized Concise
Criterion B Mathematical Communication	0-4	Mathematical language Mathematical representation Key terms Deductive method

Criterion C Personal Engagement	0-3	Significant Outstanding
Criterion D Reflection	0-3	Limited reflection Critical reflection Substantial evidence
Criterion E Use of Mathematics	0-6	Relevant Commensurate Demonstrated Thorough Correct

External assessment represents the written or oral exams administered by all IB schools on a common date at the end of two years. Exam assessments are called external evaluations because they are made by IB Exam readers.

Table 5. Assessment Component of IBDP Mathematics AA SL (IBO, 2021)

Assessment Component	**Weighting**
External Assessment (3 hours)	**%80**
Paper 1 90 Minutes No technology allowed. Formula booklet is allowed. Section A Curriculum-based compulsory short-answer questions. Section B Curriculum-based compulsory long answer questions.	40%
Paper 2 90 Minutes The use of a calculator is required. Formula booklet is allowed. Section A Curriculum-based compulsory short-answer questions.	40%

Section B Curriculum-based compulsory long-response questions.	
Internal Assessment	20%

The IBDP assessment process is structured to measure students' academic, critical thinking and problem solving skills, and their understanding of key concepts and their relationship to disciplines.

3.2 Ministry of National Education Program (MoNEP)

3.2.1 General philosophy

With the regulation made in 1946, the Ministry of National Education (MoNE) was divided into different units within itself due to the increase in workload and the development of consultancy and service areas. When the mission of the Turkish Ministry of National Education is examined, it is seen that it aims to raise individuals who have developed thinking, understanding, research and problem solving competencies; who are equipped with knowledge and skills to keep up with the new world; who communicate and cooperate in accordance with the context of this research. Its mission also includes providing an appropriate teaching environment and opportunities for the development of these skills. (MoNE, 2018).

Some of the aims of secondary education program are to prepare students for the future by equipping them with the skills to keep up with the rapidly developing and changing world, to provide qualified education based on technology, to provide suitable conditions for people to become lifelong learners, and to make necessary collaborations in employment along with education.

3.2.2 Content

Secondary education includes all general, vocational and technical education institutions that are based on primary education and provide at least four years of compulsory, formal or non-formal education. In this research, the curriculum of Anatolian High Schools,

which is one of the secondary education institutions affiliated with the General Directorate of Secondary Education, will be examined. Anatolian High Schools are educational institutions that aim to prepare students for higher education programs according to their interests, abilities, and achievements. In the Anatolian School Program, all students take the same Mathematics course in the 9th and 10th grades; while in the 11th and 12th grades, after they make their specialization area selections, they take it as an elective course with different levels of difficulty according to the field of study they choose (MoNE, 2018).

When the MoNEP Secondary Education mathematics syllabus are examined, it is emphasized that in order for individuals to keep up with the rapid changes in science and technology, the changing needs of society, innovations and developments in teaching and learning approaches, they need to develop skills such as producing knowledge, using knowledge functionally in life, problem solving, critical thinking, being entrepreneurial, being determined, having communication skills, empathy, contributing to society and culture, etc.

The title “Our Values” is common in MoNE secondary education booklets that the importance of the education system to provide individuals with values such as friendship, selfcontrol, honesty, respect, love, patience responsibility, justice, patriotism and benevolence as well as academic success and certain knowledge and skills is emphasized (MoNE, 2018).

In MoNEP Mathematics syllabus, under the title of “Competencies”; the competencies, which are the range of skills that students will need in their educational, social, and characteristic, business lives, both nationally and internationally, are specified as eight key competencies in the Turkish Qualifications Framework (TQF). These competencies are (MoNE, 2018);

-Communication in native tongue

-Digital capability

-Mathematical proficiency and core capabilities in technology /scienceLearning how to learn

-Initiative and entrepreneurship

-Civic and social proficiency

-Communication in foreign languages

-Cultural expression and recognition.

3.2.3 MoNEP's focus on mathematics

While there is a single program for grades 9 and 10, students in grades 11 and 12 choose their fields according to their interests and career choices. In 11th and 12th grades, Elective Mathematics can be chosen in line with the student's interests and aspirations and the higher education programs they aim for; Elective Basic Mathematics can be chosen by students who do not prefer a mathematics-oriented program in Vocational and Technical, Fine Arts and Sports High Schools and Anatolian High Schools (verbal-language).

The purpose of the MoNE Secondary Education Mathematics syllabus is stated as follows (MoNE, 2018):

> With the program, students;
>
> -Develop problem solving skills by looking at problems from different perspectives,
>
> -To gain mathematical thinking and application skills,
>
> -Use mathematics in a correct, effective and useful way,
>
> -Value mathematics and mathematics learning,
>
> -Recognizes the historical process of mathematics, scientists who have contributed to the progress of mathematics and their works,
>
> -Develop an approach and reach a certain level of knowledge about whether a situation they encounter is a problem for them (s. 11).

The MoNEP tenth-grade Mathematics syllabus component is given in Table 6 (MoNE, 2018).

Table 6. MoNEP Tenth-grade Mathematics Syllabus Component (MoNE, 2018)

Syllabus Component	**Suggested Teaching Hours**
Topic 1- Data, Counting, Probability	38
Topic 2- Number and Algebra Functions Polynomials Quadratic Equations	108
Topic 3- Geometry Quadrilaterals and Polygons Space Geometry	70
Total Teaching Hours	216

3.2.4 Assessment of MoNEP

The MoNE Secondary Education Program argues that it is not possible for assessment and evaluation to cover a common process that is suitable for everyone and valid for everyone; there should be flexibility and maximum diversity in this process. At this point, it is stated that teachers and educational practitioners should follow an original and creative process that is suitable for conditions such as individual, course content, school facilities, socio-economic level, etc. For this reason, in order to serve as a road map for teachers and educational practitioners, assessment and evaluation approach of MoNEP is presented in the guide as a framework (MoNE, 2018).

Written Exam: At least two exams are administered in each semester. According to the decision taken at the beginning of the year, three exams can be administered for each semester in courses with six or more weekly class hours. Some of the written exams may be administered jointly according to the decision of MoNE. Unless there is a special case, the exam duration is one class hour, i.e. 40 minutes. Exams must be written exams with

open-ended items, but in each semester, one of the exams can be matching, true-false, short-answer or multiple-choice (MoNE, 2016).

At the end of their four-year high school education, students are required to take the exam prepared by Student Selection and Placement Center (ÖSYM) which is under Higher Education Council (YÖK) in order to make university and career choices. This is not a MoNE exam, but it has great influence on the students' career choice and future. Therefore, it affects the syllabus and teaching approaches. This multiple-choice exam is administered in three stages according to the level of the courses. The first session is the Basic Proficiency Test; the second is Proficiency in Field, and the third is Proficiency in Language.

Project: Students work on a course and subject of their choice, encouraging students to conduct research and analysis. These works are evaluated and graded by the teacher (MoNE, 2016).

Performance Work: This is the grade given by the teacher to students in terms of classroom behavior, participation in social activities, sense of responsibility, communication, homework, and class attendance (MoNE, 2016).

4. METHOD

In this section, you can find explanation the research design, the documents, data collection and data analysis.

4.1 Research Design

In this study, a qualitative thematic content analysis study was used to determine whether in Mathematics syllabus of the International Baccalaureate Diploma Program and the Ministry of National Education Secondary Education Program differ in their approaches to metacognition.

Qualitative research is a type of research that encompasses a range of philosophical orientations and approaches. Document (content) analysis is carried out by examining various communicative materials such as documents, interviews, computer-aided resources, books (Cohen & Morrison, 2007). In qualitative research, content analysis is used to analyze documents, and content analysis is a systematic process for describing content communication (Merriam, 2018). Thematic analysis is a method for systematically identifying, organizing, and providing insights into patterns of meaning (themes) in a textual data set (Braun & Clarke, 2012).

In this study, the researcher defined the problem of comparing the curricula in the context of metacognition as a result of having experience in both programs and the research questions were put forward. For this purpose, the data obtained from the syllabus documents in the context of metacognition and its components were coded and categorized.

4.2 Documents

In the study conducted with thematic content analysis method, the official curricula of the Ministry of National Education (MoNE) Secondary Education Program tenth-grades Mathematics syllabus published in 2018 (MoNE, 2018) and the official curricula of the International Baccalaureate Diploma Program (IBDP) Mathematics: Analysis and Approaches (AA) Standard Level (SL) guide (IBO, 2021) published in 2019 and last updated in November 2020 were used as primary sources for data collection.

4.3 Data Collection

For this study, International Baccalaureate Diploma Program (IBDP) Mathematics Analysis and Approaches (AA) Standard Level (SL) syllabus (IBO, 2021) and the Ministry of National Education (MoNE) Secondary Education Program Mathematics tenth-grade syllabus (MoNE, 2018) were used. The content analysis of the titles given in Table 7 was made on the basis of metacognition and metacognitive skills.

Table 7. The titles examined in IBDP Mathematics AA SL (IBO, 2021) and MoNE Secondary Education Mathematics tenth-grade syllabi (MoNE, 2018)

Table of Contents of MoNE Secondary Education Mathematics	**Table of Contents of IBDP Mathematics AA SL**
1. MoNE Secondary Education Programs	1. Introduction
2. Implementation of the Secondary Education Program	2. Syllabus
3. Structure of MoNE Secondary Education Mathematics Program	3. Assessment

4.4 Data Analysis

The thematic content analysis method was used to compare the similarities and differences of the International Baccalaureate Diploma Program (IBDP) (IBO, 2021) and the Ministry of National Education (MoNE) Secondary Education Mathematics (MoNE, 2018) syllabus in terms of philosophy, teaching and learning approaches, assessment, and teacher support materials in the context of metacognition. The studies of Merriam (2018), Cohen & Morrison (2007), Braun& Clarke (2012) were used in this analysis.

Within the scope of the research, MoNE Secondary Education Mathematics tenth-grade syllabus and IBDP Mathematics: Analysis and Approaches Standard Level (SL) guides were examined line by line and codes were extracted by marking word by word based on

metacognition and metacognition components. The codes were then categorized according to the component they represented.

Initially, 32 codes were extracted, and the number of codes was reduced to 24 by evaluating them in terms of metacognition. As a result of the evaluation of the codes within the framework of metacognition and metacognition components, nine codes were formed. These codes were clustered in terms of their common features and 27 categories and then three themes were obtained. Categories are major groupings of structures or key features of the text that show connections between units of analysis (Cohen & Morrison, 2007, s. 478). In the document, according to the categories, the codes were expressed with color representations and organized on the spreadsheet as shown in the Appendix 3.

Table 8. Themes and Categories indicating Metacognition in the documents of IBDP (IBO, 2021) and MoNEP Mathematics Syllabi (MoNE, 2018)

THEMES	**SUB-THEMES**	**CODES**	**IBDP Syllabus**	**MoNEP Syllabus**
Metacognition	Awareness Understanding, Metacognitive skills Control of cognitive experiences Learning to learn	MC	PHILOSOPHY-GENERAL INFORMATION COURSE COMPONENTS	PHILOSOPHY-GENERAL INFORMATION COURSE COMPONENTS
Metacognitive Knowledge	Declarative knowledge: Procedural knowledge Conditional knowledge	MCKn MCKn-Dk MCKn-Pk MCKn-Ck	ATL-ATT ASSESSMENT	ATL-ATT ASSESSMENT

Metacognitive Regulation	Problem-solving Prediction Planning Monitoring Reflection Evaluating-Checking-Testing Thinking Critical Thinking Analyzing Recognizing Using strategy Desicion-making Taking action Transfering the skills Producing and constructing knowledge Reasoning Taking risk Self-management	MCRg-Pr MCRg-Pl MCRg-Ev MCRg	SUPPORT FOR TEACHERS	SUPPORT FOR TEACHERS

The syllabus of the International Baccalaureate Diploma Program (IBDP) Mathematics Analysis and Approaches (AA) Standard Level (SL) and the Ministry of National Education (MoNE) Secondary Education Mathematics Program were examined in terms of metacognition and metacognitive processes, and the words and phrases directly or indirectly related to metacognition were identified and coded. Then, based on Flavell's definitions, they were clustered under three main themes as "*Metacognition*", "*Metacognitive Knowledge*," and "*Metacognitive Regulation and Evaluation*" and coded as *MC*, *MCKn*, and *MCRg*, respectively (Flavell, Metacognition and Cognitive Monitoring, 1979).

In the "*Metacognition*" theme, words and phrases expressing the existence and definition of metacognition in curricula were identified. Since metacognition is defined as the awareness of one's own cognitive processes, it is clear that awareness is a prerequisite for metacognitive awareness. For this reason, the word "*awareness*" was considered as a metacognition marker and determined as a sub-theme of the metacognition theme inferring from the sentences in the syllabi. Again, in order to recognize metacognitive knowledge, to realize and carry out metacognitive processes, it is necessary to first

understand the concept, problem, relationships between concepts, processes, principles. In this respect, "*understanding*" is addressed as a marker in the theme of metacognition (Nickerson, 1985).

The expressions "*metacognitive skills*", "*control of metacognitive skills*" and "*learning to learn*" were determined as sub-themes of the metacognition theme because they express the definition and existence of metacognition.

In the "*Metacognitive knowledge"* theme, based on the studies cited by Hartman, metacognition is divided into sub-themes as "*declarative knowledge"*, which is the knowledge of what one knows; "*procedural knowledge"*, which is the knowledge of how to act; and "*conditional knowledge"*, which is the knowledge of when and under what conditions to perform cognitive functions (Brown A. L., 1987; Janis E. Jacobs, 1987; Gregory Schraw, 1995 cited from (Hartman, 2002)).

In the "*Metacognitive Regulation and Evaluation"* theme, the mental strategies necessary for metacognition are discussed. In the literature, four basic regulation skills are emphasized (Deseote and Roeyers, 2002; Schraw and Moshman, 1995; Deseote, Roeyers, Buysee, 2001; Lucangeli and Cornoldi, 1997 cited from Özsoy Gökhan, 2008). For this reason, the sub-themes of "*predicting"*, "*planning"*, "*monitoring"* and "*evaluating"* were created as organizing strategies. In the Metacognitive Regulation and Evaluation theme, the mental strategies necessary for metacognition are discussed. In the literature, four basic regulation skills are emphasized (Deseote and Roeyers, 2002; Schraw and Moshman, 1995; Deseote, Roeyers, Buysee, 2001; Lucangeli and Cornoldi, 1997 cited from Özsoy Gökhan, 2008). For this reason, the sub-themes of "*predicting"*, "*planning"*, "*monitoring"* and "*evaluating"* were created as organizing strategies. Polya's steps related to the problem-solving process are also related to metacognitive processes in terms of understanding the problem, remembering previous learning, choosing the appropriate one among the strategies for solution, decision making, interpreting and evaluation of the results. In the context of this relationship, *"problem solving"* was considered as a sub-theme of the Metacognitive Regulation and Evaluation theme. Similarly, "*analyzing"* a situation or problem, being aware of what they have about the relevant subject and *taking action"*, "*transferring appropriate skills"*, "*criticizing"* the event in all aspects,

recognizing new situations that may occur, "*reasoning"*, and "*taking risk"* as a result of these are important in terms of metacognitive skills.

Table 9. The frequencies of codes in IBDP (IBO, 2021) and MoNEP Mathematics syllabi (MoNE, 2018)

THEMES	**SUBTHEMES**	**CODES**	**Frequencies MoNEP**	**Frequencies IBDP**
Metacognition	Awareness, Understanding, Metacognitive skills, Control of cognitive experiences, Learning to learn	MC	3	51
Metacognitive Knowledge	Metacognitive knowledge	MCKn	0	4
	Declarative Knowledge	MCKn-Dk	1	13
	Procedural Knowledge	MCKn-Pk	0	1
	Conditional Knowledge	MCKn-Ck	0	1
Metacognitive Regulation and Evaluation	Reflection, Thinking, Critical Thinking, Analyzing, Recognizing, Using strategy, Desicion-making, Taking action, Transfering the skills, Producing and constructing knowledge, Reasoning, Taking risk, Prediction, Monitoring	MCRg	9	102
	Problem-solving	MCRg-Pr	4	17
	Planning	MCRg-Pl	1	7
	Evaluating	MCRg-Ev	0	6

Trustworthiness: In this study, to increase trustworthiness two different reliable sources obtained from the websites of the IB Organisation and MoNE were examined through content analysis. These sources are the IBDP Mathematics Analysis and Approaches Guide, and the MoNE Secondary Education Mathematics syllabus downloaded from ibo.org and meb.gov.tr websites, respectively.

In the process of collecting and analyzing the data, the three studies by Cohen and Morrison (2007), Lincoln and Guba (1985), and Merriam (2018), were used. In Lincoln and Guba's book (Lincoln & Guba, 1985), while the issue of reliability is addressed, Lincoln and Guba provide techniques such as member checks, peer debriefing, prolonged participation and persistent observation (prolonged, in-depth contact with salient features), reflexive diaries (introspective diaries that show the researcher's mind processes, philosophical position, and the basis of his/her decisions about the research) that will provide a useful check and balance system that can be used in research.

The researcher held regular meetings and consultations with her consultant who is an expert in IB. Since the researcher herself has 10 years of experience in institutions implementing the MoNE Secondary Education Program and 5 years of experience in schools implementing the IB Diploma Program, she has quite an in depth knowledge of both curricula and has regularly shared ideas with teachers, IB coordinators, and administrators teaching in IBDP and MoNEP. From the moment she decided to work on metacognition as a research topic, she read, took notes, and compiled the literature and on the concept of metacognition.

5. RESULTS AND DISCUSSION

5.1 Results

This chapter aims to provide a deeper understanding of the characteristics, findings, and key elements of the study to provide answers to the research questions set out in the previous chapters.

5.1.1 The similarities and differences between IBDP mathematics AA SL and MoNE secondary education mathematics syllabi in terms of metacognition

In this study, the IBDP Mathematics Analysis and Approaches Standard Level syllabus (IBO, 2021) and the Ministry of National Education Secondary Mathematics tenth-grade syllabus (MoNE, 2018) were examined in the context of metacognition.

The topics examined in both programs are given in Table 7. Accordingly, when the syllabus structures are examined, the components of the program and the relationship between these components and mathematics, the skills to be gained, and teaching and learning approaches are given in more detail in the IBDP syllabus, than in the MoNE syllabus.

In the MoNE Secondary Education Mathematics syllabus, it is emphasized that the focus of MoNE is on human beings and that the current syllabus aims to provide individuals with 21st century skills such as creativity, communication, problem-solving, knowledge generation, benefiting society and culture, and critical thinking on a global scale. In addition to equipping individuals with knowledge and skills, it is stated that the syllabus offers a syllabus without distancing them from their culture, moral, professional and national values, universal and local issues (MoNE, 2018). For this reason, it is stated that MoNE wants to raise a whole person in terms of knowledge, skills, values and beliefs. Similarly, the IBDP aims to equip individuals with IB Learner Profile attitudes and help them become citizens of the world by developing their critical thinking, problem solving, creativity, communication and language skills (IBO, 2021).

In this study, these skills, which are aimed to be acquired in both secondary education programs, are discussed within the framework of metacognition. In the MoNE Secondary Education Program Mathematics syllabus, it is stated that curricula are created in a structure that directs the use of metacognitive skills, provides meaningful and permanent learning, is solid and associated with previous learning, and is integrated with other disciplines and daily life around values, skills and competencies (MoNE, 2018, s. 4). In the same syllabus, under the title "Competencies", the definition of learning to learn is given (MoNE, 2018, s. 6-7).

All these statements show that MoNE is aware of the concept of metacognition and offers content that focuses on using and developing metacognitive skills. At this point, in the content analysis conducted with the coding method, when the entire guide is examined, it is concluded that metacognition and cognitive skills that will contribute to metacognitive skills are used less in MoNE compared to IBDP, and that there are significant differences in the general framework. See Table 9.

In particular, it is seen that the skills in the sub-themes of "Metacognition (MC)" and "Metacognitive Regulation (MCRg)" are included more in the IBDP than in the MoNE. See Table 10.

Table 10. A Comparison of frequency of theme MC and MCRg in IBDP (IBO, 2021) and MoNEP Syllabi (MoNE, 2018)

THEMES	SUBTHEMES	CODES	Freq. MoNEP	Freq. IBDP
Metacognition	Awareness, Understanding, Metacognitive skills, Control of cognitive experiences, Learning to learn	MC	3	51

Metacognitive Regulation and Evaluation	Reflection, Thinking, Critical Thinking, Analyzing, Recognizing, Using strategy, Desicion-making, Taking action, Transfering the skills, Producing and constructing knowledge, Reasoning, Taking risk, Monitoring, Prediction	MCRg	9	102

In the introductory part of the MoNE Mathematics tenth-grade syllabus, especially the sub-themes of "metacognitive skills", "learning to learn" and "thinking about thinking" were found. However, there is very little reference to cognitive skills and awareness about them in the later parts of the syllabus. In the introductory statements of the IBDP Mathematics AA SL syllabus, words referring to metacognition and metacognitive skills are not directly used. However, there are a lot of references to metacognition and metacognitive skills through the sub-themes of 'questioning', 'analyzing', 'evaluating', 'critical thinking', 'constructing knowledge', 'declarative and conditional knowledge' and 'decision making'. See Table 11.

Table 11. The frequency of codes in Philosophy and Introduction in IBDP (IBO, 2021) and MoNEP Mathematics Syllabi (MoNE, 2018)

THEMES	**SUBTHEMES**	**CODES**	**Philosophy and Content of MoNEP**	**Philosophy and Content of IBDP**
Metacognition	Metacognitive skills Learning to learn	MC	Using of metacognitive skills (f=1) Learning to learn (f=2)	How we know what we claim to know

Metacognitive Knowledge	Declarative knowledge Conditional knowledge	MCKn-Dk MCKn-Ck	Awareness of learning needs and processes (MCKn-Dk f=1)	Choose subject that particularly interest them Aware of own perspective and how they might differ from others
Metacognitive Regulation and Evaluation	Inquiring Analysis Evaluation Critical thinking Constructing knowledge Making desicion	MCRg	Acquire, process and adapt new knowledge and skills (f=1) Previous learning (f=1) Producing knowledge (f=1) Problem-solving (f=1) Critical thinking (f=1) Taking the initiative (f=1) Risk-taking (f=1) Planning (f=1)	Inquiring (f=3) Evaluate a range of points view Critical thinking (f=2) Analysis and analysis knowledge (f=2) Making their choices Construction of knowledge

f represents how many times the item is repated.

The IB Learner Profile, one of the main elements of the IB Diploma Program, aims to support individuals not only academically but also intellectually, personally, emotionally and socially (IBO, 2010).

A review of the IB Learner Profile in the context of metacognition and metacognitive skills is given below.

Inquirers: A sense of curiosity leads to inquiring. Inquiring encourages individuals to take an active role in learning, the development of self-awareness, and the development of monitoring and interpretation skills. In this respect, the ability to question supports the development of metacognitive skills. Similarly, the tendency of curious individuals to explore and seek solutions to questions and challenges also helps problem-solving.

Thinkers: Students are encouraged to think about and learn from their own learning and experiences. Being a thinker encourages students to apply critical thinking skills, analyze information and consider different perspectives. The problem solving process is based on thinking. Analyzing the problem, searching for solutions and deciding on the appropriate one, analyzing the situation after the problem solving process are directly related to thinking skills and the development of thinking skills directly affects the problem solving process.

Knowledgable: The fact that knowledgeable individuals have deep knowledge and understanding in many areas brings with it a greater awareness of cognitive processes. This increased awareness contributes to the development of metacognitive skills such as self-monitoring and self-evaluation. Similarly, strategic thinking, which is an outcome of knowledge, is a metacognitive skill that helps to plan learning experiences. Being knowledgeable improves problem-solving skills by allowing individuals to approach problems critically and from multiple perspectives.

Communicator: Empathy is the most powerful key to communication. Both trying to experience how the other person feels and evaluating one's own communication are important in terms of developing metacognitive skills. For effective communication, the individual must first be aware of his/her own communication. The ability to express thoughts and ideas clearly also improves problem solving skills in terms of collaboration, effective resource utilization and better identification of solutions.

Principled: A principled individual is expected to adhere to rules, ethical principles and values in their actions. It can be said that the interpretation of these rules, ethical principles and values encourages the development of metacognitive skills in the context of evaluating and deciding what one can comply with. Being principled affects decision making by emphasizing ethical and moral values in problem solving. Principled

individuals are more likely to evaluate the positive and negative effects of different solution methods due to their high sense of responsibility.

Open-minded: Considering alternative perspectives supports the development of metacognitive skills in terms of improving the ability to review and evaluate one's own thinking. At the same time, being open-minded supports the problem solving process in terms of seeking alternative ways to find the most appropriate solution to a problem, accepting and developing new ideas.

Caring: Individuals who think about themselves and care about their own wishes care more about local and global events or problems around them. This shows that sensitivity and metacognitive skills feed each other indirectly, if not directly. Again, thinking about the problems of others and being highly aware individuals also bring problem-solving skills.

Risk-takers: Taking a risk in a subject develops metacognitive skills in terms of thinking about possible situations about that subject, predicting the attitude to be displayed in case of an undesirable situation, and encouraging the evaluation of alternative situations. Similarly, risk-taking skill brings along the ability to face the problem and be more assertive in the problem-solving process.

Balanced: Being aware of our intellectual, physical and emotional interdependence with other people and the world we live in, reflecting on our actions to maintain this connection, and controlling our actions encourage metacognitive skills. Problem solving skills can be used to take necessary precautions by making predictions against the disruption of this balance and to ensure that the problem does not affect or has little effect on individuals and the environment we live in.

Reflective: Reflection is an important component of metacognition. Developing the habit of reflecting on one's learning experiences and thought processes supports the development of metacognitive skills. The development of an individual's reflection skills enables his to determine the strategy to be used in the problem solving process, to find what he/she needs to improve in his, and to analyze more effectively how to take action in a new problem situation.

In MoNEP, the effects of the social, academic and personal skills, which are aimed to be acquired in order to prepare students for their future lives from both national and international perspectives and which are included in the competencies determined by the Turkish Qualifications Framework (TQF), on metacognitive and problem solving skills are examined below (MoNE, 2018):

Communication both in mother tongue and foreign languages will be analyzed together as they are both language skills. Individuals express their concepts, feelings and thoughts verbally or in writing using grammar and language skills and engage in linguistic interaction. The development of language skills enables individuals to express themselves better and to make better sense of and interpret their feelings and thoughts. In this respect, the effective use of language knowledge and skills also activates the use of metacognitive skills in the context of reflecting one's thoughts and expressing oneself. Language development also strengthens problem solving skills in terms of understanding what the problem is, communicating to solve the problem, carrying out the process more easily and making sense of it.

Mathematical competence and core competencies in science/technology: In MoNE syllabi (MoNE, 2018);

> Mathematical competence is the development and application of mathematical thinking to solve a range of problems encountered in everyday life. Competence in science refers to the ability and desire to draw on the body of knowledge and methodology for explaining the natural world to define questions and produce evidence-based conclusions (s. 6).

Both definitions indicate that problem solving is at the center of mathematics and science. The development of mathematical skills such as analytical thinking, using graphs, tables and modeling enables the use of different strategies in problem solving. In this context, the awareness of missing skills, the processes of applying and analyzing the ways necessary for the acquisition of mathematical and scientific competencies also strengthen metacognitive skills.

Digital competence: Digital competence includes the ability to analyze useful and useless content, to evaluate useful content, and to use digital resources correctly when needed in

this age where technology has penetrated every aspect of our lives. The development of these skills supports the development of metacognitive and problem-solving skills, enabling individuals to choose and evaluate what is appropriate for them and to find solutions to complex situations.

Learning to learn: According to the definition given in the MoNE Secondary Education Program, this competency includes the skills of pursuing and persisting in one's own learning, being aware of learning needs and processes, and coping with difficulties for successful learning (MoNE, 2018).

Social and civic competencies: According to the definition (MoNE, 2018),

> These competencies include personal, interpersonal and intercultural competencies; they encompass all forms of behavior that enable individuals to participate effectively and constructively in a diversified society and working life; and equip them with the characteristics to resolve conflicts when necessary (s. 7).

Citizenship requires individuals to be aware of their rights and responsibilities and to think critically about them, to have the sensitivity and problem-solving skills to cooperate and communicate on social issues. From this perspective, the development of all these skills also encourages metacognition and problem solving skills.

Initiative and entrepreneurship: It includes the skills of creativity, innovation, risk-taking, planning, and awareness of ethical values that individuals should possess in order to put new ideas into action (MoNE, 2018). The skills of an individual who is preparing to become an entrepreneur to be knowledgeable about the relevant field, to plan for the goal, to take risks by anticipating obstacles on the way, to manage the crisis situation in case of need, to communicate effectively, to search for various solutions and to decide on the appropriate one support the development of metacognitive and problem-solving skills.

Cultural awareness and expression: It is stated in the manual that in MoNE syllabi (2018), "*It is an appreciation of the importance of creative expression of views, experiences and feelings using a variety of mass media, including music, performing arts, literature and visual arts"* (s. 7).

The process of understanding, analyzing, comparing and critically approaching one's own culture and other cultures encourages metacognitive skills. Similarly, respecting different cultures and communicating with individuals from that culture are skills that bridge metacognitive skills and cultural awareness. The use of art and music as a common language provides a framework that unifies and universalizes emotions. Art is born out of creativity, and creativity involves making connections between different thoughts and objects, effective expression, and awareness of environmental situations and events, which leads to the development of metacognitive skills.

When the competencies specified in MoNE and IBDP are compared, the ten core Learner Profile attributes in the IBDP are more detailed and comprehensive than the competencies specified by MoNE. It can be said that;

-communication competency in mother tongue and foreign language corresponds to the skills of being a communicator in IBDP;

-social and citizenship competencies corresponds to the skills of being sensitive, being principled;

-initiative and entrepreneurship competency corresponds to the skills of taking risks, thinking, being knowledgeable, being open-minded; and

-cultural awareness and expression competency meets the skills of being balanced, being open-minded, and being sensitive.

The IBDP states that the main focus of TOK courses is to help students reflect on what they know and put it into perspective, rather than to acquire new knowledge (IBO, 2022). TOK lessons encourage individuals to reflect on knowledge and knowing, to become more aware of assumptions, to examine the evidence for claims and to consider how we assess the credibility of claims. These skills are important as they contribute to metacognitive skills. At the end of TOK courses, it is expected that students' critical thinking skills, ability to critique situations, abstract thinking, and interdisciplinary connections will improve, as well as their ability to identify strategies, find alternative solutions, and decide on the appropriate choice in problem-solving processes. In IBO guide (2023) emphasize that in "*TOK is on critical thinking, characterized by*

metacognition, evaluation, justification, arguments, claims and counterclaims, reflection on underlying assumptions and different perspectives" (s. 40).

As a result of his study on the comparison of IBDP and MoNE students in terms of different variables, Midilli (2020) concluded that students learned how to evaluate the strengths and weaknesses of their work, how to improve them, and how to guide future researchers while searching for answers to various questions in TOK courses and associating other courses with TOK and preparing IA reports; this process enabled them to develop varying perspectives and develop metacognitive understanding (Midilli, 2020).

In the IBDP, the CAS component is one of the courses that will enable students to become not only academically successful individuals, but also individuals who take action, apply what they have learned, take responsibility, be responsive and problem-solve. Within the scope of the course, students are required to take part in a project that will last at least one month. In CAS projects, students have the opportunity to directly participate in processes such as planning, forecasting, taking initiative, problem solving, decision making, collaboration, evaluation, data collection, and awareness raising. For this reason, CAS is one of the components where the constructivist perspective can be implemented most easily. CAS also contributes to individualization in the program by allowing learners to be guided according to their interests, curiosities and needs.

The five CAS stages are as follows in IBO CAS syllabi (2017):

1. Research: Students identify areas of personal growth and development as well as interests, skills and abilities that will be used when considering opportunities for CAS experiences. Students explore what they want to do and identify the purpose of their CAS experience. In the case of service, learners identify a need they would like to address.

2. Preparation: Students clarify roles and responsibilities, develop a plan of action, identify identified resources and timelines, and acquire all the skills needed to participate in the CAS experience.

3. Action: Students implement their ideas or plans. This often requires decision-making and problem solving. Learners can work individually, with partners or in groups.

4. Reflection: Learners describe what happened, express their feelings, generate ideas, and ask questions. Reflection can take place at any time during CAS to provide greater understanding, help review plans, learn from experiences and make explicit links between learning outcomes for their growth, achievements and self-awareness. Reflection can lead to new action.

5. Demonstration: Learners make explicit what they have learned, how they have learned and what they have achieved, for example by sharing their CAS experience through CAS portfolios or with others in an informal or formal way (s. 17).

Among these stages, especially representation and reflection are at the center of metacognitive skills.

EE is one of the studies in IBDP where research is the most extensive and comprehensive. Students are expected to conduct in-depth research in their field of interest and write long essays on the topic they are curious about. In this process, students have the opportunity to develop skills such as time management, organization, determining the appropriate methods and tools for the problem and its solution, reaching and evaluating the results. Similarly, Internal Assessment allows students to demonstrate their knowledge and skills and to pursue personal interests without short time limits and other constraints such as written examinations.

In SL and HL the requirements for internal assessment are an individual investigation. This is a written piece of work involving the investigation of an area of mathematics.

According to the Ministry of National Education Secondary Education Institutions Regulation (2016):

Project: A project in which students work individually or as a group under the guidance of the course teacher to examine, research and interpret a subject they

have determined in line with their own wishes; to reach new information, to produce original ideas and to produce a product as a result of their conclusions;

Performance work: An individual or group work carried out under the supervision of the course teacher in order to share the gains obtained as a result of critical thinking, problem solving, reading comprehension, using creativity and research foreseen in the curriculum of the course in written, oral and/or practical form (s. 2).

In the Ministry of National Education Performance Task and Project Work - Teacher's Guidebook, the following statement is given for performance task: "*In general, it is defined as activities in which students learn to learn by developing lifelong learning strategies"* (Xu, 2010; Xu & Yang, 2015; Hong et al., 2015 cited from (MoNE, 2023)).

In this guide published by MoNE, the contributions of project work are presented as developing cognition, developing metacognitive strategies, providing practical experience, testing skills, developing time management skills, providing interdisciplinary learning, developing collaboration and developing a scientific perspective (MoNE, 2023).

Similarly, MoNE emphasizes the importance of metacognition for processes that develop metacognitive awareness such as concentration, goal setting, planning and organization, problem solving, self-evaluation, and self-correction and states that project tasks support these skills (MoNE, 2023).

The Social Responsibility and Community Service Practices guide, one of the documents published by the Ministry of National Education, includes content in the context of developing students' values and skills (MoNE, 2022). MoNE Secondary Education Mathematics tenth-grade syllabus, which was examined within the scope of this study, does not include information about performance and project processes and their contribution to learning and skills, and social responsibility and community service while the IBDP Mathematics Analysis and Approaches guide includes CAS, TOK, EE and Internal Assessment components. See Table 12.

Table 12. The frequency of themes in components of IBDP (IBO, 2021) and MoNEP Mathematics Syllabi (MoNE, 2018)

THEMES	SUBTHEMES	CODES	Components of MoNEP	Components of IBDP (TOK, CAS, EE, IA)
Metacognition	Understanding	MC	-	Understanding the world Understanding
Metacognitive Knowledge	Declarative knowledge Procedural knowledge	MCKn-Dk MCKn-Pk	-	Aware of their own perspective and the perspectives of others About how knowledge
Metacognitive Regulation and Evaluation	Inquiring Analysis Evaluation Problem-solving Critical thinking Reflect Interpretation Recognizing Reasoning Planning	MCRg MCRg-Pr MCRg-Pl MCRg-Ev	-	Inquiring (f=4) Critical thinking Analysis situations (f=2) Reflect-reflection (f=4) Interpretation (f=2) Recognizing (f=2) Plan-action plan (f=3) Problem-solving (f=3) Reasoning Evaluate the world

IBDP Mathematics AA SL course is given in Table 5 and the recommended course hours is 150, which is taught over two years. On the other hand, MoNE Secondary Mathematics tenth-grade topics given in Table 6 with recommended teaching time 216 periods of 40 minutes, which totals up to 144 hours which is taught is one academic year. This is 6 hours less than the IBDP. However, having two school years to do the 150 hour-Math content, would give the students time to be more reflective, and innovative, and would also give the teacher supported with a comprehensive teachers's guide more time and opportunity to help the students attain necessary cognitive skills.

5.1.2 The differences of assessments used in IBDP and MoNE secondary education mathematics syllabus in terms of metacognition

When the International Baccalaureate Diploma Program (IBDP) Mathemtics AA SL syllabus (IBO, 2021) and the Ministry of National Education Secondary Education Mathematics syllabus (MoNE, 2018) are examined in terms of assessment elements and criteria, it is seen that the IBDP guidelines frequently include mental situation and actions that will contribute to metacognitive skills. There is no information on metacognition and metacognitive skills under the title of measurement and evaluation in the MoNEP syllabus. The findings are given in Table 13.

Table 13. The frequency of themes in assessment element and criteria of IBDP (IBO, 2021) and MoNEP Matematics syllabi (MoNE, 2018)

THEMES	**SUBTHEMES**	**CODES**	**Assessment elements and criteria of MoNEP Syllabus**	**Assessment elements and criteria of IBDP Syllabus**
Metacognition	Understanding Awareness	 MC	-	Understanding (f=22) Their personal interest

Metacognitive Knowledge	-	-	-	-
Metacognitive Regulation and Evaluation	Inquiring Analysis Evaluation Problem-solving Reflect Interpretation Recognizing Reasoning Planning Prediction Using strategy	MCRg MCRg-Pr MCRg-Pl MCRg-Ev		Inquiring (f=4) Analysis (f=4) Reflect-reflection (f=14) Interpretation (f=3) Recognizing (f=2) Plan-action plan (f=2) Problem-solving (f=6) Reasoning Evaluate (f=2) Predict-predictions (f=2) making suggestions for suitable sources of information

Students are required to score a certain number of points in a multiple-choice exam prepared by ÖSYM in order to enter a university. Although ÖSYM is not under MoNE officially, this exam effects the MoNEP curriculum and approaches to teaching and learning greatly even though it is not a graduation requirement within MoNEP. It is quite different from the IBDP external assessment exams. IBDP external assessment includes progressive and contextualised question types that require the use of skills such as knowledge, understanding, interpretation, use of technology and experimental knowledge. In addition, in this program, students are required to meet CAS, EE, TOK,

IA components in order to graduate. In the IBDP program, exams are administered twice a year at a common date and time in IB schools around the world.

In the Ministry of National Education curriculum, there is only one nationwide common exam per semester in the nineth grade. However, there is no common exam at the tenth-grade level. Teachers choose the appropriate scenarios published by the Ministry of National Education in terms of the number of questions and learning outcomes according to their grade levels and prepare and administer the exam accordingly.

MoNEP does not allow the use of technology in any exam during the assessment process. Students are also required to know the formulas of the topics. In the IBDP, on the other hand, students can use calculators, bilingual dictionaries and formula booklets in some of the exam sessions.

Internal assessment is a research process in which students can demonstrate their research, problem solving, understanding, reflection, mathematical knowledge and skills. In the evaluation of this process, teachers and the IBDP evaluation commission evaluate students' work within the framework of five criteria: *Presentation, Mathematical communication, Personal engagement, Reflection,* and *Use of mathematics.* During this research, students, under the guidance of their teachers, carry out a research on a topic they choose according to their interests. In order for the learners to have an idea about what their interests are, they need to be aware of their knowledge and skills about what they like and how they can carry out a research in which field and make decisions. Then, they perform mental actions that require the use of metacognitive skills such as preparing for the research, planning, identifying a research question, identifying resources and strategies to help the research, evaluating the process, receiving feedback from the teacher, identifying the technology they will need for their research and developing themselves in this regard. When the research is completed, the students' research must be uploaded to the system to be evaluated by the IB supervisors after the evaluation of their teachers until the deadline determined by the IB Organisation. There is no structured evaluation process similar to that of the IB for projects and performance studies in the MoNEP. The subjects of the projects and performance studies, the skills to be measured and evaluated, and the deadlines are determined according to the common decision of the department members.

5.1.3 The support given to teachers in terms of metacognitions in IBDP and MoNE secondary education mathematics syllabi

The International Baccalaureate Program Mathematics Analysis and Approaches Standard Level syllabus (IBO, 2021) and the Ministry of National Education Secondary Mathematics syllabus (MoNE, 2018) were analyzed in terms of the support provided to teachers. While there is one directive in the MoNE Mathematics syllabus in terms of teacher support, this number is 18 in the IBDP. These statements are given in Table 13. This situation reveals that IB teachers will be more knowledgeable about what and how to do in terms of promoting metacognitive skills. The IBDP Mathematics AA SL syllabus includes information on how teachers should focus on relevant skills, which also makes frequent referrals to the Teacher Support Material (2021). Mathematics AA Teacher Support Material (2021) contains a toolkit for teachers to plan their lessons to meet the needs of their students. In one section, the toolkit provides information on how to develop problem-solving skills. This is because one of the aims of DP mathematics is to help students "*develop logical and creative thinking and patience and perseverance in problem solving to instill confidence in using mathematics* (IBO, 2019)." How the mathematics classroom and physical resources can be organized to support problem solving is also included in this guide.

Table 14. The frequency of codes of Support for Teachers in IBDP (IBO, 2021)and MoNE Mathematics syllabi (MoNE, 2018)

THEMES	SUBTHEMES	CODES	Support for teachers in MoNEP	Support for teachers in IBDP
Metacognitive Regulation and Evaluation	Inquiring Problem-solving Reflection Interpretation Using strategy Critical thinking Checking Organizing	MCRg	Students' processes of constructing mathematical knowledge, multiple representations and materials should be supported.	Engaged in structured inquiry and greater critical and creative thinking empower teachers to create clearer strategies students' prior learning seek the recommendation of their teacher when deciding as they organize and relate facts and topics mathematical inquiry, by students' critical thinking and problem-solving skills checking generalizations risk takers and inquiry, conceptual understanding, collaboration prior learning encourage the development of mathematical thinking skills for teachers to generate reflection strengths and weaknesses in order to help develop students' understanding and capabilities.

When the findings in Table 14 are analyzed, it is seen that in the IBDP Mathematics Analysis and Approaches Standard Level syllabus, teachers are given instructions to support the development of students' problem-solving, questioning, reflection, critical and creative thinking skills. In the context of thinking skills, particular emphasis is placed on metacognition, reflection, critical thinking, creative thinking, and transfer. Metacognition or being aware of one's own learning processes is considered as fundamental for the development of other thinking skills. The course objectives, assessment objectives, and assessment tasks of the IBDP emphasize the development of higher-order thinking skills such as critical thinking, creative thinking, and transfer (IBO, 2021). In this respect, the supporting teachers in the development of these skills is of great importance for the program.

The MoNE Secondary Mathematics syllabus emphasizes the need to support students' processes of constructing mathematical knowledge, multiple representations, and materials, but lacks guidance for teachers on how to do these and where to find resources that will aid them.

6. CONCLUSION AND RECOMMENDATIONS

Discussion

When IBDP Mathematics AA SL and MoNE Secondary Education Mathematics tenth-grade syllabi are compared in terms of contribution to metacognition and metacognitive skills, it is seen that both programs focus on cognitive skills and include practices related to them. Although the MoNEP guide includes words and phrases such as metacognition and learning to learn, it was observed that cognitive skills that would contribute to the development of these skills were not included. In the IBDP syllabus, although there are no expressions that directly indicate the existence of the concept of metacognition such as metacognition, learning to learn, thinking about thinking, the guideline frequently emphasizes the skills of planning, predicting, problem solving, reflecting, evaluating, monitoring, critical thinking, analyzing, reasoning, and decision making that will contribute to the development of metacognition and metacognitive skills.

The IBDP Mathematics AA SL syllabus explains the IB Learner Profile (LP) in detail and presents it in an integrated structure with the mathematics course (IBO, 2021, s. 14). The Learner Profile was analyzed in the context of metacognition and metacognitive skills and it was concluded that these ten basic qualities support metacognitive skills. The MoNE program also refers to skills as competencies, which are a set of skills that individuals will need in their personal, social, academic, and professional lives at both national and international levels, and considers metacognition as one of the competencies. However, its relationship with course and subject outcomes was not found in the guide.

When the components of the programs are examined, in IBDP TOK, CAS, EE, Internal Assessment constitute the core of the program. All these components encourage students to take an active role in the learning process and to develop the skills and problem-solving abilities given in the student profile. In a study, it was found that students tried to find answers to questions such as why yes, why no, how, how do I know, where do I know, how do I know. It is stated that students' learning to bring different perspectives to events and situations by explaining the strengths and weaknesses of their own studies, how they can improve them and how they can shed light on subsequent researchers in the evaluation

section while preparing their UA reports provides metacognitive learning as it enables students to observe and evaluate their own knowledge level and the activities they do (Midilli, 2020). This is because students are placed at the centre of the learning and development process.

IBDP keeps teachers and students under control in terms of the applicability and evaluation processes of TOK, CAS, EE and IA components. In the guidelines, the relationship between these elements and the mathematics course, related skills, assessment processes and criteria are included.

In IBDP Schools TOK may be applied both as a stand-alone subject and in integrated into other subjects. The fact that it can also be applied in mathematics offers teachers the opportunity to discuss with their students and to reveal their skills such as questioning, thinking, critical thinking, and expressing their thoughts explicitly. At the same time, discussing the concepts and questions that encourage them and help to change their negative prejudices against mathematics and increase student participation. In teaching the syllabus of the Ministry of National Education content, because of content overload teachers are usually in a hurry to cover with the subject, and they do not have the time to encourage students in this way and become aware of their difficulties of skills.

When creativity, activity, and service components of the CAS on IBDP Mathematics AA SL syllabus CAS are analyzed, it is seen that is is similar to the participation of students in social responsibility projects in schools implementing the MoNE curriculum. However, there is no supportive information in the MoNE Secondary Education Mathematics tenth-grade syllabus in terms of skills, courses, and social responsibility. On the other hand, the IBDP Mathematics syllabus explains CAS and includes explanations about its integration with Mathematics course. CAS activities, planning, setting content-related goals, communicating them, and keeping reflection and evaluation reports after the activity contribute greatly to learning and the development of student's cognitive awareness.

The description of projects and performance tasks in the MoNE assessment and evaluation process is not included in the guidelines; the definition of these activities is given in the MoNE legislation. The lack of a mandatory and clear framework for projects and performance tasks leads to different standards and implementation methods for each

school, each department or each teacher.

In IB Schools in Türkiye because IB Programs are not recognized by MoNE for application as a single program. IB is applied as an add-on program. Therefore, IB Schools generally create their own school policies and applications models blending these two programs. For example, In MoNE schools, performance and project tasks are given only in the form of presentations or test solving as required, while in IB Schools in Türkiye, they developed students' skills such as research, strategy development, comprehension, evaluation, self-evaluation, use of mathematical knowledge, time management, etc. and are graded according to rubrics. This situation shows that in MoNE, due to the lack of a standardised structure, students are not provided with common objectives and common outcomes in terms of the skills they are aimed to acquire.

When we look at the assessment and evaluation approaches in syllabi, it is seen that the assessment processes in IBDP are structured in a way to support students' skill development. Allowing the use of calculators and formula booklets in IBDP exams is aimed at enabling students to use skills such as using this information, interpreting, analyzing, inferring, evaluating, and using technological tools appropriately and correctly. In national curriculum in Türkiye, the university exam and is a multiple-choice exam and is based on knowledge and memorization and written exams in MoNE is knowledge-based that requires formula memorization. On the other hand, MoNEP teaching and assessing approaches are influenced by the central exams administered by ÖSYM which are multiple-choice and verify of them are knowledge-based questions and the use of any materials such as formula booklets, calculators are not allowed in the exam.

When the assessment and evaluation approaches are analyzed, it is concluded that the assessment processes in IBDP are structured in a way to support students' skill development.

The IBDP offers a syllabus on a global scale by structuring and enriching it in terms of learning and teaching approaches, skills, teacher development programs and resources. It is observed that the IBDP external assessment is implemented in all countries on a common date and with the same content in a qualified manner. Comparatively, MoNE content is assessed by the criteria the teachers specify.

If we consider the "*Probability*" subject as one of the subjects learned in common in both programs; in MoNE Mathematics lessons, the Probability of Simple Events and probability concepts are given, and daily life examples are included. In the IBDP Mathematics Analysis and Approaches SL Mathematics syllabus, probability is structured in a way that allows the measurement of the probability of occurrence of events and, most importantly, to evaluate the risk as a result of this and in connection with the subject of statistics. Both statistics and probability provide important representations that enable us to make predictions, make valid comparisons and make informed decisions (IBO, 2021). Similarly, organizing, analyzing, and interpreting data, proving, and using different statistical tools contribute to the ability to predict and draw conclusions. In addition, the subject is supported by the processes of calculating probability, using information, and evaluating the results by using technologies such as simulation, spreadsheets, and statistical applications. The sample exam question on probability published by MoNE (MoNE, 2023) and the questions in the Mathematics AA SL Paper 2 exam administered by the IB Organisation (IBO, 2021) are given in Appendix 1 and Appendix 2.

MoNEP Mathematics tenth-grade sample exam question in Appendix 1, is a question that students can solve with their knowledge of probability concepts and basic mathematical operation knowledge. Similar question types are asked in IBDP Mathematics AA exams and the question types given in Appendix 2 are also included in IBDP Mathematics exams. To solve this question, students need to use the steps of using a calculator, reading a graph, finding the area, proving it, recognizing equality in the next step, realizing the relationship of the problem with other mathematics subjects, proving it, and evaluating the results for each step. In this respect, it is seen that IBDP Mathematics AA exams have more comprehensive questions in a format that contributes to students' cognitive and metacognitive development such as: recognizing, planning, proving, evaluating, thinking, mathematical communication.

Teachers must contribute to the development of metacognition by designing lessons with approaches that encourage students to access and reconstruct the information and put students at the center in the problem-solving process rather than transferring information in the classroom. When both syllabi are analyzed in terms of their contribution to teachers'

metacognition and metacognitive skills, the data show that IBDP is more guiding and supportive to the teacher in terms of knowledge and skills. As someone who has been teaching in MoNE institutions for ten years and in an IB school for the last 5 years, the contribution of the IB ecosystem to my personal and academic development cannot be denied. The components such as TOK and Mathematics discussions in the lessons, the use of calculators, the presentation of the subjects in relation to the learner profile, IB mathematics themes, etc. require the teacher to be prepared before the lesson and support him/her to improve himself/herself.

Conclusion

It is important that students become caring individuals who know how to use up-to-date technology, conduct research, ask questions, are aware of their own cognitive processes, approach global problems with a solutionist approach and contribute to science. In this respect, national and international curricula should focus on skill development as well as academics.

In this study, IB Diploma Programme Mathematics Analysis and Approaches Standard Level and MoNE Secondary Education Mathematics tenth-grade syllabi were examined to reveal the similarities and differences of the both syllabi in terms of developing metacognition and metacognitive skills.

The data obtained as a result of the analysis of the relevant documents with the coding method reveal that the IB Diploma Programme Mathematics Analysis and Approaches Standard Level syllabus focuses more on metacognition and cognitive skills that will contribute to developing metacognitive skills compared to the MoNE Secondary Mathematics syllabus. As well as the assessment and evaluation processes supporting cognitive and metacognitive skills development for students, directives and resource suggestions for teachers increase their awareness in terms of developing these skills.

Implication for Further Research

Suggestions that can be made in line with the research findings:

-More research on the impact of innovative educational programs such as IB in respect of metacognitive skills can be undertaken.

-In order to improve students' cognitive and metacognitive skills, how changes should be made in the MoNE syllabus needs to be investigated.

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APPENDICES

APPENDIX 1

MoNEP Secondary Education Mathematics Tenth-grade Sample Exam Question

Kazanım: 10.1.2.2. Olasılık kavramı ile ilgili uygulamalar yapar. *Gain: 10.1.2.2. Makes applications related to the concept of probability.*

Bir sınıfta bulunan 22 öğrenciden 11'i basketbol, 12'si futbol oynamaktadır. 19 öğrenci bu sporlardan en çok birini oynadığına göre sınıftan rastgele seçilen bir öğrencinin yalnız futbol oynama olasılığını bulunuz.

Out of 22 students in a class, 11 play basketball and 12 play football. Since 19 students play at most one of these sports, find the probability that a randomly selected student in the class plays only football.

APPENDIX 2

IBDP Mathematics AA SL Exam Question 2023 MAY P2

[Maximum mark: 8]

The weights, W grams, of bags of rice packaged in a factory can be modelled by a normal distribution with mean 204 grams and standard deviation 5 grams.

(a) A bag of rice is selected at random.

Find the probability that it weighs more than 210 grams. [2]

According to this model, 80% of the bags of rice weigh between w grams and 210 grams.

(b) Find the probability that a randomly selected bag of rice weighs less than w grams. [2]

(c) Find the value of w. [2]

(d) Ten bags of rice are selected at random.

Find the probability that exactly one of the bags weighs less than w grams [2]

APPENDIX 3

THEMES	SUBTHEMES	CODES	MoNEP	IBDP
Metacognition	*Awareness* *Understanding* *Metacognitive skills* *Control of cognitive experiences* *Learning to learn*	***MC***	**PHILOSOPHY-GENERAL INFORMATION** **PAGE 4 MC** In this way, a curriculum that **directs the use of metacognitive skills,** provides meaningful and permanent learning, is solid and associated with previous learning, and is integrated with other disciplines and daily life around values, skills and competencies has been created. **PAGE 7** **MC and MCKn-Dk Learning to learn:** The competence to pursue and persist in learning so that the individual can organise his/her own learning action individually or in groups,	**PHILOSOPHY-GENERAL INFORMATION** **IB Mission Statement MCRg** The International Baccalaureate aims to develop **inquiring**, knowledgeable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect. **PAGE 2 MCRg-MCRg-Ev** It is a broad-based two-year course that aims to encourage students to be knowledgable and **inquiring,** but also caring and compassionate. There is a strong emphasis on encouraging students to develop intercultural understanding, open-mindedness, and the attitudes necessary for them to respect and **evaluate a range of points of view.** **PAGE 2 MCKn-Dk - MCRg** In each of the academic areas students have flexibility **in making their choices**, which
Metacognitive Knowledge	*Declarative knowledge* *Procedural knowledge* *Conditional knowledge*	***MCKn*** ***MCKn-Dk*** ***MCKn-Pk*** ***MCKn-Ck***		
Metacognitive Regulation and Evaluation	*Problem-solving* *Planning* *Monitoring* *Prediction* *Reflection* *Evaluating* *Checking* *Testing* *Thinking*	***MCRg*** ***MCRg-Pr*** ***MCRg-Pl*** ***MCRg-Pd*** ***MCRg-Mn*** ***MCRg-Ev***		

	Critical Thinking *Analyzing* *Recognizing* *Using strategy* *Desicion-making* *Taking action* *Transfering the skills* *Producing and constructing knowledge* *Reasoning* *Taking risk*		including effective time and information management. This competence includes the **individual's awareness of learning needs and processes by recognising** existing opportunities and the ability to cope with difficulties for a successful learning action. **PAGE 7 MCRg-MC** It means **acquiring, processing and adapting new knowledge and skills** as well as seeking and utilising guidance support. **Learning to learn** mobilises learners to build on prior learning and life experiences in order to use and apply knowledge and skills in a variety of contexts, such as the home, workplace, education and	means they can **choose subjects that particularly interest them** and that they may wish to study further at university. **PAGE 3 MCRg** At both levels many skills are developed, especially those of **critical thinking** and **analysis.** **PAGE 3 MC- MCRg** Theory of knowledge (TOK) is a course that is fundamentally about **critical thinking** and **inquiry into the process of knowing** rather than about learning a specific body of knowledge. The TOK course examines the nature of knowledge and **how we know what we claim to know.** It does this by encouraging students to **analyse knowledge** claims and explore questions **about the construction of knowledge.** **PAGE 3 MCKn-Dk MCKn-Ck** The task of TOK is to emphasize connections between areas of shared knowledge and link them to personal knowledge in such a way that an individual becomes more **aware of his or her own perspectives** and **how**

			training environment. **PAGE 4** **MCRg-Pr** This change defines an individual who can **produce knowledge,** use it functionally in life, **solve problems**, **think critically**, be entrepreneurial, determined, have communication skills, empathise, contribute to society and culture, etc. **PAGE 7** **MCRg-Pl-MCRg Initiative** and entrepreneurship : It refers to the individual's ability to transform thoughts into action. It includes creativity, innovation and **risk-taking** as well as the ability to **plan and manage projects** to achieve goals.	**they might differ from others.** **PAGE 3 MCKn-Dk** Creativity, activity, service (CAS) is at the heart of the Diploma Program. The emphasis in CAS is on helping students to **develop their own identities**, in accordance with the ethical principles embodied in the IB mission statement and the IB learner profile. **PAGE 3 MCKn-Dk** An authentic learning experience, it provides students with an **opportunity to engage in personal research on a topic of choice,** under the guidance of a supervisor. **ATL-ATT** **PAGE 3 MCRg** empower teachers to create clearer **strategies for facilitating learning experiences** in which students are more meaningfully engaged in structured **inquiry** and greater **critical** and creative **thinking.** **PAGE 4 MCRg** The five approaches to learning (**developing thinking skills**, social skills, communication skills, **self-management skills** and research skills) along with the six

			MATHEMATICS COURSE **PAGE 11** **MCRG-Pr** For the **solution of new problem**s arising from the changes in our lives, especially technological developments; the value of mathematics Individuals who are able to think mathematically, who have developed mathematical thinking power, and who can use mathematics in modelling and **problem-solving** are needed more than ever. **PAGE 11** **MCRG-Pr** To develop **problem solving** skills by looking at problems from different angles. **PAGE 11** **MCKn-Dk** It is aimed to develop a per**spective on whether a problem they encounter in life** is a problem for them and to reach a certain	approaches to teaching (teaching that is **inquiry-based**, conceptually-focused, contextualized, collaborative, differentiated and informed by assessment) encompass the key values and principles that underpin IB pedagogy. **IB MISSION AND THE IB LP** **PAGE 4 MCKn-Dk** The Diploma Program aims to develop in students **the knowledge, skills** and **attitudes they will need to** fulfill the aims of the IB, as expressed in the organization's mission statement and the learner profile. In teaching, learning and assessment, academic honesty serves to promote personal integrity, engender respect for the integrity of others and their work, and ensure that all students have an equal opportunity to **demonstrate the knowledge and skills they acquire during their studies.** **IBDP MATHEMATICS COURSE-TOK-CAS-IM** **PAGE 6 MCRg - MCRg-Pr** The side of

			level of knowledge. **PAGE 11** **MCRg** Students' **construction of mathematical knowledge** should be supported by multiple representations and materials. **SUPPORT FOR TEACHERS** **PAGE 11** **MCRg** Students' processes of **constructing mathematical knowledge**, multiple representations and materials should be supported.	mathematics that is based on describing our world and **solving practical problems** is often carried out in the context of another area of study. Mathematics is used in a diverse range of disciplines as both a language and a tool to explore the universe; alongside this its applications include **analyzing trends, making predictions,** quantifying risk, exploring relationships and interdependence. **PAGE 6 MCKn-Dk-MC** For this reason there are two different subjects in mathematics, each available at SL and HL These courses are designed for different types of students: those who wish to study mathematics as a subject in its own right or to **pursue their interests in areas** related to mathematics, and those who wish to gain **understanding** and competence in how mathematics relates to the real world and to other subjects. **PAGE 6 MCKn-Dk** In making this selection, individual students should be advised to take into

				account the following factors: • **their own abilities** in mathematics and the type of mathematics in which they can be successful • **their own interest** in mathematics and those particular areas of the subject that may **hold the most interest for them.** **PAGE 7 MCRg-Pl their academic plans**, in particular the **subjects they wish** to study in the future. **PAGE 7 MCKn their choice of career.** **PAGE 7 MCKn** Mathematics: analysis and approaches is for **students who enjoy developing their mathematics** to become fluent in the construction of mathematical arguments and develop strong skills in mathematical thinking. **PAGE 8 MCKn-MCRg-Pr-MC** This course recognizes the need for analytical expertise in a world where innovation is increasingly dependent on a **deep understanding** of mathematics. **Students who wish to take** Mathematics: analysis and approaches at higher level will have strong

				algebraic skills and the ability to understand simple proof. They will be **students who enjoy spending time** with problems and get pleasure and satisfaction from **solving challenging problems.** **TOK-CAS-IM** **PAGE 8 MCKn-Pk-MCRg-MCKn-Dk** The relationship between each subject and theory of knowledge (TOK) is important and fundamental to the DP. The theory of knowledge course provides an opportunity for students to **reflect on questions about how knowledge** is produced and shared, both in mathematics and also across different areas of knowledge. It encourages **students to reflect on their assumptions and biases**, helping them to become more **aware of their own perspective** and **the perspectives of others** and to become "**inquiring**, knowledgeable and caring young people" (IB mission statement). **PAGE 9 MCRg** Students' attention

				should be drawn to questions relating theory of knowledge (TOK) and mathematics, and they should also be **encouraged to raise such questions themselves** in both their mathematics and TOK classes. **(Inquiring)** **PAGE 9 MCRg** Is it there, "waiting to be discovered", or is it a human creation? **(Inquiring)** **PAGE 9 MCRg** International-mindedness is a complex and multi-faceted concept that refers to a way of thinking, being and acting characterized by an openness to the world and a **recognition** of our deep interconnectedness to others. One way of fostering international-mindedness is to provide opportunities for **inquiry** into a range of local and global issues and ideas. **PAGE 9 MCRg-MC-MCRg-Ev--MCRg-Pl** CAS and mathematics can complement each other in a number of ways. Mathematical knowledge provides an important key to

				understanding the world in which we live, and the mathematical skills and techniques students learn in the mathematics courses will allow them to **evaluate the world** around them which will help them to develop, **plan** and deliver CAS experiences or projects. **PAGE 9 MCRg** An important aspect of the mathematics courses is that students develop the ability to systematically **analyse** situations and can **recognize** the impact that mathematics can have on the world around them. **PAGE 9 MC** Despite all its undoubted power for **understanding** and change, mathematics is in the end a puzzling phenomenon. **PAGE 10 MCRg - MCRg-Pr An awareness of how** mathematics can be used to represent the truth enables **students to reflect** critically on the information that societies are given or generate, and **how** this **influences** the allocation of resources or the choices that

				people make.This systematic **analysis** and critical **reflection** when **problem solving** may be inspiring springboards for CAS projects. **PAGE 10 MCRg - MCRg-Pr- MCRg-Pl plan**, write and implement a "mathematics scavenger hunt" where younger students tour the school answering interesting mathematics questions as part of their introduction to a new school • as a CAS project students could **plan** and carry out a survey, create a database and **analyse** the results, and make suggestions to **resolve a problem** in the students' local area. This might be, for example, surveying the availability of fresh fruit and vegetables within a community, **preparing an action plan** with suggestions of **how to increase availability or access**, and presenting this to a local charity or community group **PAGE 10 MCRg** Some will be familiar with an **inquiry approach**, and may have had an

				opportunity to complete an extended piece of work in mathematics. **PAGE 11 MCRg** The MYP assessment objective of **thinking critically** also corresponds to the higher-order assessment objectives of communication and **interpretation**, and of **reasoning** that are expected from a DP mathematics student. **PAGE 14 MCRg** This concept refers to using well-founded, logical mathematics to come to a true and accurate conclusion or a **reasonable interpretation of results** **ATL-ATT ON MATHEMATICS** **PAGE 13 MC** In DP mathematics courses, conceptual **understanding**s are key to promoting deep learning. This is followed by suggested conceptual **understandings** relevant to the content within the topic, although this list is not intended to be prescriptive or exhaustive. The twelve concepts identified below support conceptual **understanding**, can inform units of work and can help to

				organize teaching and learning. **PAGE 13 MCRg** Concepts represent the vehicle for students' **inquiry** into issues and ideas of personal, local and global significance, providing the means by which they can explore the essence of mathematics. **PAGE 13 MCRg - MCRG-Pr - MC-MCRg-Ev** Students use conceptual **understandings** as they **solve problems**, **analyse** issues and **evaluate decisions** that can have an impact on **themselves, their communities** and the wider world. **PAGE 14 MCRg** These approaches and tools are intrinsically linked to the IB learner profile, which encourages learning by experimentation, **questioning** and discovery. **PAGE 14 MCRg - MCRg-Pr** Teachers should therefore provide students with regular opportunities to learn through mathematical **inquiry**, by making frequent **use of strategies** which stimulate students' **critical thinking** and **problem-solving skills.**

				PAGE 15 MCRg - MCRg-Pr Mathematical modelling is an important technique used in **problem solving,** to make sense of the real world. It is often used to help us better understand a situation, to **check the effects** of change or to inform **decision-making.** There is often a fine balance needed between the simplicity and the accuracy of the model. The first stage involves **choosing or fitting a suitable mathematical representation** to the context. This representation is tested to **evaluate** whether or not it returns expected results. Once a satisfactory model is established it can be applied or used to explain a situation, **check the effects** of change or to inform **decision-making.** **PAGE 16 MCRg** The **testing stage** allows the results returned by the model to be **reflected** upon and adaptations to be made to the model if necessary. The process of mathematical modelling requires **critical reflection**

				throughout the process. **PAGE 17 MCRg-MC** Proof in mathematics is an essential element in developing **critical thinking.** Engaging students in the process of proving a statement enables a deeper **understanding** of mathematical concepts. **PAGE17 MCRg** Proofs encourage students to **reflect** on mathematical rigour, efficiency and the elegance of showing that a statement is true. **PAGE 18 MCRg-Pr** Developing an appreciation of how developments in technology and mathematics have influenced each other is one of the aims of the courses and using technology accurately, appropriately and efficiently both to explore new ideas and to **solve problems** is one of the assessment objectives. **PAGE 18 MC** Teachers can use technology to support and enhance student **understanding** in many ways including:...to enhance **understanding** of concepts that would otherwise be restricted

				by lengthy numerical calculations or algebraic manipulation **PAGE 18 MCRg-MC** Students can also use technology to engage with the learning process in many ways including the following: • to develop and enhance their own personal conceptual **understanding** • to search for patterns • to **test** conjectures or generalizations • to **justify** interpretations • to collaborate on project based work • to help organize and **analyse data.** **PAGE 18-19 MC** The key to successful learning of mathematics with technology is the fine balance between the teacher and student use of technology, with carefully chosen use of technology to support the **understanding** and the communication of the mathematics itself. **PAGE 19 MCRg** As teachers tie together the unifying themes of mathematical **inquiry**, mathematical modelling and the use of technology, they should begin by providing substantial guidance and then gradually encourage

				students to become more independent as **inquirers** and **thinkers**. **PAGE 19 MCRg** The terms "**analysis**" and "analytic approach" are generally used in the guide to indicate an algebraic approach that may not require the use of technology. **PAGE 19 MC** This structure gives prominence and focus to the aspects of teaching and learning, including conceptual **understandings**, content and enrichment. Each topic begins with a section on conceptual **understandings.** Details are given of which of the twelve key concepts could be used to relate to the topic. Essential understandings give details of the overall aims of the topic and then content-specific conceptual **understandings** give specific details of the aims and purpose of the topic and sub-topics. **PAGE 19 MCRg-MC** Teachers should create a learning environment in which students are comfortable as **risk takers** and **inquiry,** conceptual **understanding**,

				collaboration and use of technology feature prominently. **PAGE 20 MCRg** For mathematics courses at both SL and HL, it is expected that 30 hours will be spent on developing **inquiry,** modelling and investigation skills. **PAGE 21 MC-MCRg** This time gives students opportunities in the classroom for undertaking an **inquiry-based** approach and focusing on conceptual **understanding** of the content, developing **their awareness of** mathematics in local and global contexts, gives them opportunities for teamwork and collaboration as well as time to **reflect upon their own learning** of mathematics. **PAGE 21 MCKn** Teachers are encouraged to make explicit where these skills might transfer across areas of mathematics content and allow students to **reflect upon where these skills transfer to other subjects** the student is studying. **PAGE 22 MC - MCRg** 1. develop a **curiosity** and

				enjoyment of mathematics, and appreciate its elegance and power 2. develop an **understanding** of the concepts, principles and nature of mathematics 3. communicate mathematics clearly, concisely and confidently in a variety of contexts 4. develop logical and creative thinking, and patience and persistence in **problem solving** to instil confidence in using mathematics 6. **take action** to apply and **transfer skills** to alternative situations, to other areas of knowledge and to future developments in their local and global communities 7. appreciate how developments in technology and mathematics influence each other 8. **appreciate the moral, social and ethical questions arising from the** work of mathematicians and the applications of mathematics 9. appreciate the universality of mathematics and its multicultural, international and historical perspectives 11. develop the ability to **reflect critically**

				upon their own work and the work of others 12.independently and collaboratively extend their **understanding** of mathematics. **PAGE 20 MC** Use of technology: Suggestions as to how technology can be used in the classroom to enhance **understanding.** • Enrichment: Suggestions for further discussions that may reinforce **understanding.** **ASSESSMENT PAGE 23 MCRg-Pr - MCRg-MC Problem solving** is central to learning mathematics and involves the acquisition of mathematical skills and concepts in a wide range of situations, including non-routine, open-ended and real-world problems. Having followed a DP mathematics course, students will be expected to demonstrate the following: 1. Knowledge and **understanding**: 2. **Problem solving:** Recall, select and use their knowledge of mathematical skills, results and models in both abstract and real-world contexts to so**lve problems.** Communication and

				Interpretation Transform common realistic contexts into mathematics; comment on the context; sketch or draw mathematical diagrams,graphs or constructions both on paper and using technology; record methods, solutions and conclusions using standardized notation; use appropriate notation and terminology. 4. Technology: Use technology accurately, appropriately and efficiently both to explore new ideas and to **solve problems.** 5. **Reasoning: Construct** mathematical arguments through use of precise statements, logical deduction and inference and by the manipulation of mathematical expressions. 6. **Inquiry approaches**: Investigate unfamiliar situations, both abstract and from the real world, involving organizing and **analyzing** information, making conjectures, drawing conclusions, and **testing** their validity. **PAGE 24 MCRg - MCRg-Pr-MC** Assessment objectives in practice:

				Knowledge and **understanding**, **problem solving,** communication and **interpretation, reasoning, inquiry approaches.** **PAGE 25 MCRg-Pr** Syllabus component: The toolkit and the mathematical exploration Investigative, **problem-solving** and modelling skills development leading to an individual exploration. **PAGE 70 MCRg-MC** It is concerned with providing accurate and helpful feedback to students and teachers on the kind of learning taking place and the nature of stu**dents' strengths and weaknesses in order to help develop students' understanding** and capabilities. **PAGE 71 MC** These arrangements enable candidates with diverse needs to access the examinations and demonstrate their knowledge and **understanding** of the constructs being assessed. **PAGE 80 MC** It enables students to demonstrate the application of their skills and knowledge

				and to pursue **their personal interests** without the time limitations and other constraints that are associated with written examinations. **PAGE 81 MCRg** the **analysis** of the work by a web-based plagiarism detection service such as. **PAGE 81 MC** acquiring the necessary knowledge, skills and **understanding.** **PAGE 81 MCRg** Group data or measurements can be combined to provide enough information for individual **analysis** and this should be clearly described in the written exploration. **PAGE 81 MC** It is important that students demonstrate how they incorporated sources and collaborative ideas into their work and that they always show their **understanding** and engagement in the work as described in the assessment criteria. **PAGE 81 MC** This weighting should be reflected in the time that is allocated to teaching the knowledge, skills and **understanding**

				required to undertake the work, as well as the total time allocated to carry out the work. **PAGE 82 MCRg** The teacher is expected to give appropriate guidance at all stages of the exploration by, for example, directing students into more productive routes of **inquiry, making suggestions** for suitable sources of information, and providing advice on the content and clarity of the exploration in the writing-up stage. **PAGE 82 MCRg-Pl** Students need to start **planning their explorations** as early as possible in the course. **PAGE 82 MCRg-Pl** Ethical guidelines should be adhered to throughout the **planning** and conducting of the exploration. **PAGE 83 MCRg** The specific purposes of the exploration are to: develop students' personal insight into the nature of mathematics and to develop t**heir ability to ask their own questions** about mathematics. **PAGE 83 MC** Students should be able to explain all stages of their work in

				such a way that demonstrates clear **understanding.** **PAGE 83** **MC** In addition to testing the objectives of the course, the exploration is intended to provide students with opportunities to increase their **understanding** of mathematical concepts and processes, and to develop a wider appreciation of mathematics. **PAGE 84** **MC** enable students to develop the qualities of patience and persistence, and to **reflect** on the significance of their work. **PAGE 84** **MCRg** Criterion D **Reflection** **PAGE 85** **MCRg** These include thinking independently or creatively, presenting mathematical ideas in their own way, exploring the topic from different perspectives**, making and testing predictions.** **PAGE 86** **MCRg** **MC** **MCRg-Ev** Criterion D: **Reflection** Further (but not exhaustive) examples of personal engagement at different levels are given in the teacher support material

				(TSM).There is evidence of limited **reflection**. 2 There is evidence of meaningful **reflection**. 3 There is substantial evidence of **critical reflection**. The **"reflection"** criterion assesses how the student reviews, **analyses** and **evaluates** the exploration. Although **reflection** may be seen in the conclusion to the exploration, it may also be found throughout the exploration. Simply describing results represents limited **reflection**. Some ways of showing meaningful **reflection** are: linking to the aims of the exploration, commenting on what they have learned, considering some limitation or comparing different mathematical approaches. **Critical reflection** is **reflection** that is crucial, deciding or deeply insightful. It will often develop the exploration by addressing the mathematical results and their impact on the student's **understanding** of the topic. Some ways of showing **critical**

				reflection are: considering what next, discussing implications of results, discussing strengths and weaknesses of approaches, and **considering different perspectives.** Substantial evidence means that the **critical reflection** is present throughout the exploration. **PAGE 86-87 MC** Criterion E: Some relevant mathematics is used. Limited **understanding** is demonstrated. Limited **understanding** is demonstrated. Some knowledge and **understanding** are demonstrated. Relevant mathematics commensurate with the level of the course is used. Good knowledge and **understanding** are demonstrated. The mathematics explored is correct. Thorough knowledge and **understanding** are demonstrated. Obtaining the correct answer is not sufficient to demonstrate **understanding** (even some **understanding**) in order to achieve level 2 or higher. For knowledge and **understanding** to be

				thorough it must be demonstrated throughout. Students are encouraged to use technology to obtain results where appropriate, but **understanding** must be demonstrated in order for the student to achieve higher than level 1, for example merely substituting values into a formula does not necessarily demonstrate **understanding** of the results. **PAGE 86 MC** It leaves the impression that the student has developed, through their approach, a complete **understanding** of the context of the exploration topic and the reader better understands the writer's intentions. **PAGE 90 MC** **MCRg Interpret** Use knowledge and **understanding** to **recognize** trends and draw conclusions from given information. **Predict** Give an expected result**.**

RESUME

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