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ANTICIPATORY THINKING SKILLS AMONG STUDENTS FROM SELECTED SECONDARY SCHOOLS IN MALAYSIA

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Abstract— In the rapidly evolving landscape of technology, globalisation, and environmental change, secondary school students in Malaysia face multifaceted challenges in preparing for an uncertain future. Anticipatory thinking skills (ATS) are pivotal in navigating these challenges, yet their presence and development among students remain underexplored. The objective of this study was to explore whether Malaysian secondary school students demonstrate ATS, and to identify the ways in which such skills may be expressed through their perceptions, experiences, and responses to future-oriented scenarios. A qualitative approach was adopted, with focus group discussions (FGDs) conducted in small groups of two to three students across diverse states, including Perak, Pahang, Penang, Kedah, Selangor, Putrajaya, Kuala Lumpur, Negeri Sembilan, and Terengganu, to ensure broad representation. Thematic exploration revealed five key components of ATS: forecasting, risk assessment, scenario planning, opportunity recognition, and adaptability. Students demonstrated the ability to anticipate risks based on environmental cues and past experiences, assess vulnerabilities in their surroundings, generate alternative plans for family, school, and community life, identify opportunities for learning and contribution, and adjust flexibly to changing conditions. The findings suggest that Malaysian secondary school students do possess elements of ATS, although these are shaped by personal experiences, educational settings, and socio-cultural contexts. The insights provide guidance for educators and policymakers in designing strategies to strengthen ATS, thereby equipping students with the resilience and foresight needed to navigate an unpredictable future. This study contributes to the limited body of research on anticipatory thinking in Malaysia by offering qualitative evidence of whether and how secondary school students display these skills, linking classroom practices with broader educational and societal needs.

Keywords—adaptability, anticipatory thinking skills, forecasting, opportunity recognition, secondary school students,

I. INTRODUCTION

The term anticipatory thinking (AT) denotes a cognitive process in which individuals proactively consider and plan for potential future events, outcomes, or possibilities. It entails the capacity to envision potential scenarios, anticipate potential difficulties or opportunities, and make decisions based on these considerations (Klein, Snowden, & Chew, 2011). In the rapidly evolving landscape of technology, globalisation, and environmental uncertainty, secondary school students are confronted with multifaceted challenges that require not only knowledge but also cognitive agility to navigate. One such essential cognitive capacity is anticipatory thinking.

AT enables learners to envision scenarios, anticipate risks or opportunities, and make informed decisions in the present that are mindful of the future (Van Niekerk & Terblanché-Greeff, 2020).

Scholars emphasise that AT involves the deliberate exploration of possible futures through processes such as mental simulation, recognition, and preparation (Klein et al., 2011; Hough, Larue, & Juvina, 2020). These processes allow individuals to construct, evaluate, and communicate arguments about hypothesised scenarios, thereby fostering adaptability and proactive engagement. Beyond its individual cognitive dimensions, AT is also inherently social. It supports collaboration, communication, and collective problem-solving (Kioupi & Voulvoulis, 2022). For students, this means that anticipatory dispositions contribute not only to their academic performance but also to their ability to engage effectively in teamwork, navigate interpersonal challenges, and develop resilience in the face of uncertainty.

The benefits of anticipatory thinking are wide-ranging. Anticipatory beliefs shape motivation, engagement, and satisfaction in learning environments. For example, students' predictions about their own academic performance can strongly influence their level of engagement and satisfaction in online courses (Ye, Lee, & He, 2022). Similarly, anticipatory socialisation prepares students for future professional roles by equipping them with relevant competencies and reducing anxiety associated with transitions into the workforce (Lombardi &Mather, 2016).). In sustainability education, anticipatory competence is recognised as a key capability that enables learners to plan long-term solutions for complex challenges such as resource management, environmental protection, and climate adaptation (Redman & Wiek, 2021; Mróz & Ocetkiewicz, 2024).

Research also indicates that anticipatory thinking plays a crucial role in enhancing critical thinking, problem-solving, and metacognitive awareness. By analysing scenarios and evaluating multiple outcomes, students improve their decision-making and learn to regulate their own thinking processes. Studies have demonstrated that project-based learning which incorporates anticipatory thinking strengthens students' ability to foresee future issues, such as challenges in achieving clean water and sanitation, and to devise innovative solutions (Ramadhani, Azizah, & Nasrudin, 2023; Lestari, Widodo, & Eliyawati, 2024). These proactive skills are particularly valuable in addressing socio-economic challenges faced by students at risk of dropping out, who often must navigate uncertain futures with limited resources (Muñoz-Erickson et al., 2021).

In addition to academic outcomes, anticipatory thinking fosters self-directed learning and lifelong learning habits. Students are more capable of adapting to changes in academic and professional contexts, seeking resources, and taking initiative by developing the ability to anticipate their own learning requirements. (He, 2022; Akhmetzyanova, 2016). This adaptability extends to social and emotional development: students who anticipate future interactions and challenges are better prepared for collaborative projects and interpersonal relationships (Lelis, 2024). Employers also increasingly demand anticipatory capabilities, particularly in fields such as healthcare, engineering, and business, where professionals must make rapid, informed decisions under uncertain conditions (Mróz, & Ocetkiewicz, 2024)).

AT also has affective and psychological benefits. Anticipatory processes can help students manage stress and reduce anxiety by preparing them for multiple possible outcomes rather than leaving them vulnerable to surprise (Aspinwall, 2005; Volkman et al., 2024). Anticipatory thinking fosters resilience and constructive behaviour in the presence of obstacles by promoting proactive coping and long-term goal setting. Furthermore, the integration of AT into curricula has been found to improve student motivation and engagement by highlighting the relevance of learning to real-world contexts (Gáspár, Hideg, & Köves, 2021).).

Despite these international insights, there is limited research examining anticipatory thinking among Malaysian secondary school students. While global scholarship affirms its benefits for critical thinking, metacognition, and proactive learning (Jamil & Abbas Rizvi, 2025; Hough et al., 2020; Ramadhani et al., 2023), little is known about how Malaysian students display these skills within their socio-cultural and educational contexts. This study therefore seeks to address this gap by exploring whether Malaysian secondary school students demonstrate anticipatory thinking skills (ATS), and identifying the ways in which such skills may be expressed through their perceptions, experiences, and responses to future-oriented scenarios.

II. LITERATURE REVIEW

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A. Conceptualising Anticipatory Thinking Skills

Your Anticipatory thinking is increasingly conceptualised as a multifaceted cognitive and metacognitive skill that integrates foresight, critical reasoning, and adaptability. At its foundation, AT requires the interplay of divergent

and convergent thinking. Divergent thinking enables learners to generate a wide range of possible scenarios, while convergent reasoning allows them to refine and evaluate these possibilities to guide informed action (Geden et al., 2019). Cognitive priming also plays a crucial role, as present thoughts and contextual cues can activate related mental pathway that prepare individuals for future contingencies (Hiatt, 2023).

AT is also a reflective, metacognitive process. Learners must continuously evaluate their goals, monitor their progress, and adjust strategies as conditions evolve. Amos-Binks and Dannenhauer (2020) frame this as "goal reasoning," where anticipatory thinkers manage uncertainty by dynamically adapting their plans. Such reasoning is vital in education, where students are regularly confronted with shifting expectations, emerging challenges, and the need to balance immediate requirements with long-term aspirations.

The measurement of AT has advanced in recent years. The Anticipatory Thinking Assessment (ANTA), developed by Geden and colleagues (2019), evaluates anticipatory responses in terms of uniqueness, specificity, and remoteness. Findings using this tool show that AT is associated with traits such as mindfulness, need for cognition, and tolerance for uncertainty, highlighting its connection to both cognitive and dispositional characteristics. This confirms that anticipatory thinking can be cultivated and assessed, offering educators a practical framework for integrating it into teaching and learning.

B. Key Components of Anticipatory Thinking Skills

The development of anticipatory thinking is supported by several interrelated components. The first involves cognitive mechanisms, such as divergent generation, priming, and creativity. These mechanisms underpin the ability to project forward, simulate possible futures, and imagine alternative strategies. Cognitive priming in particular bridges present experiences with potential scenarios, making the anticipation of future events both possible and meaningful (Hiatt, 2023).

A second component is critical and systems thinking, which ensures that anticipatory reasoning is both imaginative and analytically grounded. Critical thinking provides the capacity for careful analysis, interpretation, and evaluation of information, while systems thinking equips students to recognise interconnections and feedback loops within complex environments (Rieckmann, 2012; Guerra, Jiang, & Du, 2022). This combination of analytical and systemic perspectives strengthens students' ability to anticipate and plan effectively.

The third component, futures thinking, focuses on the structured exploration of alternative futures. It encourages learners to ask "what if" questions, to differentiate between probable, plausible, and preferable futures, and to engage with uncertainty as a constructive element of learning (Jones et al., 2012; Amer Almishari, 2024). Futures thinking not only develops foresight but also nurtures the resilience required to adapt to multiple possible trajectories.

Equally important are contextual and environmental factors. Anticipatory thinking is influenced by sociocultural contexts, values, and sustainability imperatives. For example, research in organisational and military contexts shows that effective sensemaking relies on incorporating sociocultural knowledge into anticipatory judgments (Bartlett, Nolan, & Marraffino, 2013). In sustainability education, anticipatory competence is considered essential for evaluating decisions from economic, environmental, and social perspectives (Mróz & Ocetkiewicz, 2024). These insights highlight the need to situate anticipatory thinking within learners' cultural and environmental realities.

Finally, assessment and evaluation represent a vital component of ATS. Tools such as ANTA, as well as performance rubrics in educational settings, provide structured means of assessing students' interpretive and predictive capacities (Utami et al., 2019). By systematically measuring anticipatory skills, educators can identify strength and weaknesses, design targeted interventions, and track growth over time.

Taken together, these components establish AT as a constellation of interconnected abilities rather than a single skill. The ability to forecast, plan, assess risk, recognise opportunity, and adapt to changing conditions makes AT a comprehensive cognitive and dispositional resource for learners facing uncertain futures (Geden et al., 2018, 2019).

C. Linking ATS Components to the ANTA Framework

While anticipatory thinking has been described in the literature as comprising distinct yet interrelated components — forecasting, risk assessment, scenario planning, opportunity recognition, and adaptability — the challenge lies in systematically evaluating these skills. The Anticipatory Thinking Assessment (ANTA), developed by Geden et al. (2019), provides a structured framework for doing so. ANTA operationalises anticipatory thinking through four evaluative qualities: uniqueness (the generation of novel ideas), specificity (the level of detail and concreteness), remoteness (the consideration of outcomes beyond the immediate or obvious), and diversity (the range and variety of possibilities generated).

These qualities provide a valuable analytic lens through which the components of anticipatory thinking can be understood. For instance:

• Forecasting often demonstrates specificity when students connect observable cues (e.g., rainfall) with likely outcomes, and remoteness when they identify early warning signs before events fully materialise.

• Risk assessment highlights diversity by drawing on multiple environmental or infrastructural factors and specificity in linking risks to potential consequences.

• Scenario planning is closely tied to uniqueness and remoteness, as it encourages learners to imagine alternative futures beyond immediate expectations.

• Opportunity recognition embodies uniqueness by reframing constraints into advantages and diversity by considering different ways opportunities may be leveraged.

• Adaptability reflects both specificity in making concrete adjustments and diversity in generating a range of alternative strategies when circumstances shift.

This study connects students' daily anticipatory behaviours with a theoretically verified model by situating these five components inside the ANTA evaluation framework. This not only strengthens the interpretation of findings but also situates them within a broader research tradition that emphasises creativity, foresight, and flexibility as essential skills for navigating uncertainty (Geden et al., 2019).

D. Developing ATS in Educational Settings

The cultivation of ATS among students depends on effective teaching strategies, supportive psychological traits, and the nurturing of long-term dispositions. Research shows that classroom interventions such as Socratic questioning, reading circles, creative writing, and group presentations foster both critical and anticipatory capacities (Kulamikhina et al., 2018; Arviani, Wahyudin, & Dewi, 2023). Anticipatory learning strategies, such as organising vocabulary by word families, have also been shown to improve not only language acquisition but also students' engagement with learning (Marzuki et al., 2021).

In addition to instructional practices, non-cognitive factors such as mindfulness, resilience, and social-emotional skills play an important role in shaping anticipatory capacity (Liu, Afari, & Khine, 2023). Anticipatory competence has also been linked to dispositions such as open-mindedness, truth-seeking, and maturity in problem-solving (Arviani et al., 2023). These findings suggest that ATS flourishes when both cognitive instruction and socio-emotional development are prioritised in educational environments.

E. Curriculum Integration of ATS

Scholars increasingly advocate for embedding ATS into curricula through a combination of futures thinking literacy, computational thinking, design thinking, and active learning approaches. Vidergor (2023, 2024) has introduced the concept of futures thinking literacy, which equips students to interpret the past, analyse the present, and forecast multiple possible futures. Computational thinking, when integrated into mathematics and science, enhances students' logical reasoning and strengthens their ability to tackle complex problems (Yeni et al., 2024; Pinheiro & Santos, 2025). Design thinking similarly promotes empathy, creativity, and innovation, preparing students to devise user-centred solutions in dynamic contexts (Kandi, Kumar, & Rao, 2025).

Active learning strategies and critical thinking pedagogy are also effective in strengthening anticipatory skills by engaging students in hands-on inquiry, reflection, and collaborative problem-solving (Kanokpermpoon, 2019; El-Asri & Karfa, 2024). The integration of digital technologies and AI further enhances students' capacity to simulate future scenarios and test hypotheses in controlled yet realistic environments (Patel & Lim, 2025; Ramírez-Montoya et al., 2025). Importantly, such innovations must be accompanied by sustained professional development for teachers, ensuring they are equipped with the pedagogical frameworks and confidence to cultivate anticipatory skills in diverse classrooms (Macann & Yadav, 2025; Cabrera et al., 2024).

III. RESEARCH METHOD

A. Research Design

This study employed a qualitative research design to investigate the manifestations and developmental pathways of anticipatory thinking skills (ATS) among secondary school students in Malaysia. A qualitative approach was deemed particularly appropriate as it facilitates a deeper exploration of students' perceptions, lived experiences, and the multiple factors that influence the development of ATS. The study revealed how students perceive and implement anticipatory thinking in their daily lives by obtaining comprehensive descriptions, including the tools they employ to predict future scenarios, mitigate risks, and make educated judgements.

Qualitative inquiry also provides insight into the subjective and contextual nature of ATS, recognising that these skills are shaped by individual dispositions as well as socio-cultural and educational contexts (Levitt et al., 2017; Noble & Smith, 2014). At the same time, it allows for the capture of students' voices in their own terms, highlighting the nuanced ways in which anticipatory thinking is enacted within the reality of everyday schooling (Creswell & Poth, 2018). This design therefore enabled the study to examine not only cognitive and behavioural dimensions of ATS, but also the broader cultural and institutional settings that shape how these skills emerge and evolve.

B. Participants

The study targeted Form Four secondary school students from diverse regions across Malaysia, including Perak, Pahang, Penang, Kedah, Selangor, Putrajaya, Kuala Lumpur, Negeri Sembilan, and Terengganu. A purposive sampling method was employed to ensure the inclusion of students from varied geographical locations, socio-economic backgrounds, and educational experiences. This diversity was considered essential for capturing a broad and nuanced understanding of how anticipatory thinking skills (ATS) are developed and applied across different student groups (Patton, 2015).

The inclusion criteria specified that participants should be between the ages of 15 and 17 and enrolled in public secondary schools. This age group was chosen because it represents a critical developmental stage in which adolescents begin to articulate future aspirations, engage in higher-order cognitive processes, and encounter increasingly complex academic and social challenges.

In total, 40 students participated in the study. They were organised into focus group discussions (FGDs) consisting of two to three students each. This sample size was deemed sufficient for a qualitative study, as it enabled in-depth exploration of individual experiences while also providing a diverse range of perspectives to enrich the findings.

C. Data Collection Methods

To capture comprehensive data on students' anticipatory thinking skills (ATS), focus group discussions (FGDs) were conducted as the primary method of data collection. FGDs were chosen because they encourage interaction, peer learning, and the sharing of diverse perspectives, often leading to the generation of new insights that might not surface in individual interviews (Krueger & Casey, 2015). Small groups of two to three students per session were formed to create an intimate and supportive environment where participants could speak openly, while still benefiting from the collaborative exchange of ideas. Each FGD lasted between 60 to 90 minutes and was conducted in the students' preferred language to ensure both comfort and authenticity of expression.

The FGDs were guided by a semi-structured interview protocol, which was designed to elicit students' perspectives on the five key components of ATS — forecasting, risk assessment, scenario planning, opportunity recognition, and adaptability (Geden et al., 2019). Questions were open-ended and exploratory, allowing participants to reflect on both hypothetical situations and personal experiences. Examples of prompts included:

- "How do you usually prepare for unexpected challenges in school or at home?"
- "Can you share a time when you imagined different possibilities for the future?"
- "What strategies do you use when you think something might go wrong?"

In addition to these general prompts, Scenario 1 (Flooding Risk) was developed to anchor the discussions in a concrete and contextually relevant situation. Students were presented with a scenario in which a heavy storm was forecasted, raising concerns about flooding in their area. They were asked to imagine how they would anticipate, assess, and prepare for such an event. The scenario was framed around local environmental conditions, past experiences with floods, and available weather information.

Three guiding questions were posed in relation to this scenario:

1. "Imagine that you have heard on the news that a heavy storm is approaching, and there are concerns about flooding in your area. What would you do to prepare for this?"

– This question prompted students to demonstrate their forecasting abilities by considering how they predict the likelihood and severity of a storm, using weather forecasts and prior knowledge of flood-prone areas.

2. "How do you decide what to prioritise in your preparation for a potential flood? What signs or information do you use to predict the severity of the flood?"\

– This question focused on how students prioritise risks and evaluate information sources when preparing for an uncertain future event.

3. "In your experience, have you ever had to deal with a similar situation? How did you handle it, and what did you learn from that experience?"

– This question allowed students to reflect on past experiences with floods or similar events, linking prior learning to future-oriented strategies.

The scenario-based approach employed in the FGDs facilitated students' discussions on both abstract concepts of ATS and their practical applications, especially concerning natural disasters pertinent to Malaysia. This combination of general prompts and scenario-based questions helped capture a wide spectrum of anticipatory behaviours — from everyday planning to disaster preparedness.

All sessions were conducted ethically, with informed consent obtained from both students and their guardians. The interview protocol emphasised voluntary participation, confidentiality, and anonymity. Discussions were audio-recorded and later transcribed verbatim to preserve accuracy. This method of data collection thus provided a rich, multi-layered dataset, capturing both individual reflections and group-level interactions that revealed how students anticipate, evaluate, and prepare for future events.

D. Data Analysis

The data collected from the FGDs were analysed using thematic analysis, a widely used qualitative method that involves identifying, analysing, and reporting recurring patterns within the data. Thematic analysis was chosen for its flexibility and ability to provide a rich, nuanced understanding of how students describe their experiences and perspectives regarding anticipatory thinking (Creswell, 2014). This method was particularly suited to the study's aim of capturing both individual and collective meanings, as it allows researchers to move beyond surface-level accounts and identify deeper structures in the data.

The analytic process began with familiarisation, where the research team immersed themselves in the transcripts to gain a comprehensive sense of the content. This was followed by coding, in which labels were assigned to meaningful segments of data in order to categorise and organise the information. Coding was conducted through a combination of inductive and deductive approaches: inductively, to allow codes and patterns to emerge naturally from the data, and deductively, guided by the theoretical framework of ATS, which includes forecasting, scenario planning, risk assessment, opportunity recognition, and adaptability (Geden et al., 2019).

Once the initial codes were generated, the researchers engaged in theme development, drawing on Braun and Clarke's (2006) six-phase framework: (1) familiarisation with data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the final report. This structured process ensured a systematic and transparent approach to theme generation. In line with recommendations from Gale et al. (2013) and Smith and McGannon (2018), the analysis emphasised both rigour and interpretive depth, making it possible to connect students' voices to broader theoretical concepts in anticipatory thinking.

To enhance the trustworthiness of the findings, multiple strategies were employed. Intercoder reliability was addressed by involving a second researcher who independently reviewed a subset of transcripts and coding decisions to ensure consistency and minimise subjectivity. Discrepancies were discussed and resolved through consensus, thereby strengthening the credibility of the coding framework. Peer debriefing was conducted to further refine interpretations, while member checking was used to verify the accuracy of the findings with selected participants, ensuring that the interpretations authentically reflected their perspectives (Lincoln & Guba, 1985; Cohen & Crabtree, 2008; DeJonckheere & Vaughn, 2019). These procedures collectively bolstered the validity and reliability of the study's conclusions.

Through this iterative and rigorous analytic process, the study was able to generate a set of themes that reflect the ways in which Malaysian secondary school students anticipate, interpret, and respond to future scenarios, providing valuable insights into the development and application of ATS in educational settings.

E. Ethical Considerations

In conducting this research, several ethical considerations were prioritised to ensure the integrity and respect for the rights of all participants. First and foremost, informed consent was obtained from all participants and their guardians, as they were minors. Participants were fully informed about the purpose of the study, the procedures involved, and their right to withdraw at any stage without any consequence. This was done through clear, concise consent forms written in language that was easily understandable.

Confidentiality was another key ethical consideration. All personal data collected during the study, including responses from the focused group discussions (FGDs) were anonymised to protect the identities of the participants. Any identifying information was removed, and pseudonyms were used in place of real names in the analysis and reporting of the data.

Additionally, the study adhered to the principle of voluntary participation. Students were given the freedom to choose whether they wanted to participate in the study, with no pressure or coercion involved. They were also reassured that their participation or non-participation would not affect their academic standing or relationship with the school.

To minimise any potential harm, care was taken to create a safe and comfortable environment for all participants during the FGDs. Participants were encouraged to express their thoughts freely and were assured that their responses would not be judged. We made efforts to avoid causing any distress or discomfort to the participants, particularly since the topic of anticipatory thinking might involve personal reflections on future aspirations and challenges.

Finally, the findings of the study were used solely for academic purposes, and any publications or reports arising from the research will ensure that no sensitive information or identifying details are shared. Ethical approval for the study was also sought and granted by the IIUM Research Committee (IREC) to ensure compliance with ethical research standards

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IV. FINDINGS AND DISCUSSION

The findings from the Focus Group Discussions (FGDs) reveal the key elements of forecasting, risk assessment, scenario planning, opportunity recognition, and adaptability in the students' anticipatory thinking skills (ATS). These components reflect how students anticipate future challenges, assess risks, plan for various outcomes, identify opportunities, and adapt to changing circumstances, all essential for preparing for an uncertain future.

A. Forecasting

Forecasting emerged as a prominent theme in students' anticipatory thinking, reflecting their ability to predict future events by analysing both present cues and past experiences. This skill is critical for anticipatory thinking, as it equips individuals to prepare for uncertainties and respond proactively to potential risks (Geden et al., 2019; Van Niekerk & Terblanché-Greeff, 2020).

Students in this study demonstrated forecasting through their awareness of weather patterns and recognition of signs that signal flood risks. For instance, one participant explained:

"I think flooding might occur because of the very heavy rain, usually this type of rain is unexpected. This area is often affected." [T0328]

This student predicts flooding based on heavy rainfall, demonstrating an ability to link immediate weather conditions with future risks. This reflects specificity, as the reasoning is grounded in concrete and observable cues (Geden et al., 2019). The capacity to connect rainfall intensity to flood likelihood is central to proactive disaster planning and supports findings by Van Niekerk & Terblanché-Greeff (2020), who highlights forecasting as a key anticipatory strategy.

Another student highlighted the importance of recognising early warning signs in predicting risks:

"If the rain continues, I think flash floods will definitely happen in a short time; we can already see the signs." [PA0135]

ere, the student demonstrates the ability to identify early warning signs, recognising that sustained rainfall increases the likelihood of flash floods. This exemplifies remoteness, as the student projects forward to anticipate risks before they fully materialise (Geden et al., 2019). Such foresight aligns with Akhmetzyanova's (2016) argument that recognising early cues is vital for effective risk management in uncertain environments.

The role of past experiences was also evident in students' accounts:

"From past experiences, I know that if the rain lasts for a long time, the risk of flooding increases." [PA0321]

This excerpt highlights how students employ prior knowledge to forecast future risks, applying lessons from past experiences to anticipate outcomes. This represents uniqueness, as the reasoning draws on personal history and context to shape future expectations (Geden et al., 2019). Such proactive use of experiential knowledge echoes Hough et al. (2020), who note that forecasting allows learners to transfer insights from past scenarios into present and future decision-making.

These insights affirm what the ANTA framework underscores: forecasting is not merely about prediction, but about linking past, present, and future through cognitive simulation and divergent reasoning (Hiatt, 2023; Geden et al., 2019). In educational contexts, forecasting strengthens critical thinking and problem-solving by encouraging learners to weigh alternatives and consider multiple possible outcomes (Ramadhani, Dafik, & Prastiti, 2023; Lestari, Widodo, & Eliyawati, 2024). Moreover, forecasting has broader implications for sustainability education, where students are required to anticipate long-term risks such as climate change, resource scarcity, and environmental degradation (Redman & Wiek, 2021; Mróz & Ocetkiewicz, 2024). By anticipating floods, the students in this study demonstrated the very competencies that sustainability frameworks identify as crucial for developing resilience and responsible decision-making.

Taken together, these findings reveal that forecasting among Malaysian secondary school students is both practical and cognitively sophisticated. Students drew on experiential knowledge, observable patterns, and contextual cues to anticipate flood risks, demonstrating the forward-looking orientation of ATS. Their responses confirm the theoretical proposition that forecasting reduces uncertainty, enables proactive strategies, and serves as a cornerstone of anticipatory competence across environmental, educational, and societal domains (Geden et al., 2019; Van Niekerk & Terblanché-Greeff, 2020; Hough et al., 2020).

B. Risk Assessment

Risk assessment is a critical component of anticipatory thinking, as it involves evaluating potential hazards and understanding their impacts. In this study, students demonstrated their ability to identify environmental factors such as swamps, blocked drainage, and low-lying land, all of which can exacerbate flooding. According to Geden et al. (2019), effective risk assessment requires individuals not only to recognise hazards but also to anticipate their potential impact and develop strategies to mitigate possible damage. This aligns with broader research emphasising the importance of early identification of risks for reducing vulnerability (Akhmetzyanova, 2016; Van Niekerk & Terblanché-Greeff, 2020).

For example, one student highlighted the risk posed by geographical features near their home:

"In the back of my house, there's a swamp, so if water comes from other areas, it will rise quickly." [K0215]

Here, the student identifies a swamp as a local geographical feature that intensifies flooding. This demonstrates specificity, as the student links a concrete environmental condition directly to heightened flood risk (Geden et al., 2019). By recognising the swamp's amplifying effect, the student shows an anticipatory awareness of how geography shapes vulnerability — consistent with Akhmetzyanova's (2016) observations on environmental risk factors.

Another student drew attention to infrastructural weaknesses:

"Blocked drains are a major issue; if it rains heavily, the water cannot flow and the flood gets worse." [P0141]

In this case, the student evaluates infrastructural weaknesses that heighten flooding risk. This reflects uniqueness, as the analysis expands beyond natural causes (rainfall) to include man-made factors (drainage systems) (Geden et al., 2019). Recognising these less obvious but highly influential conditions illustrates how students engage in layered risk assessments, resonating with Van Niekerk and Terblanché-Greeff's (2020) argument that identifying preventable hazards is key to reducing potential damage.

A further example of geographical risk awareness was provided by another participant:

"Low-lying land is a problem because the water can't escape to other places, so it causes the flood to rise quickly." [W0222]

This is where the student takes into account the more extensive geographical layout, emphasising that inundation is exacerbated by low-lying land. This illustrates diversity by incorporating yet another unique risk dimension, topography, into the evaluation (Geden et al., 2019). The student demonstrates anticipatory thinking as a multidimensional process that integrates environmental, infrastructural, and geographical knowledge by accounting for a variety of risk factors.

These student accounts confirm insights from the ANTA framework, where risk assessment is positioned as a forward-looking and systems-oriented process. It requires integrating critical thinking with contextual awareness to evaluate vulnerabilities, weigh possible consequences, and prepare adaptive strategies (Rieckmann, 2012; Guerra, Jiang, & Du, 2022). In educational studies, risk assessment has been associated with enhanced metacognitive awareness and proactive decision-making, especially within project-based learning environments where students are required to foresee and address potential challenges. (Ramadhani, Dafik, & Prastiti, 2023; Lestari, Widodo, & Eliyawati, 2024). Moreover, sustainability education highlights the importance of cultivating risk assessment to enable learners to evaluate environmental, social, and economic trade-offs, preparing them to navigate ong-term uncertainties (Mróz & Ocetkiewicz, 2024).

The findings of this study indicate that Malaysian secondary school students can recognise environmental and infrastructural problems within their local contexts and comprehend how these elements exacerbate flood threats. Students exhibited proactive risk assessment skills, informed by experiential knowledge, contextual awareness, and critical appraisal, aligning with global study findings. These abilities not only help students deal with immediate risks to the environment, but they also get them ready for bigger problems in society. This shows that risk assessment is an important part of being able to anticipate problems.

C. Scenario planning

Scenario planning is the process of envisioning multiple possible futures and preparing strategies for each. It allows individuals to explore changes in personal, social, or community life and to remain flexible in the face of

uncertainty. In this study, students demonstrated scenario planning by anticipating changes in family routines, school activities, and community responsibilities. This aligns with Geden et al. (2019), who emphasise scenario planning as a core element of anticipatory thinking, enabling individuals to engage in structured exploration of "what if" possibilities. Similarly, Hough et al. (2020) argue that scenario planning strengthens adaptability and resilience by encouraging learners to visualise diverse futures and plan accordingly.

One student reflected on how increasing academic responsibilities might affect family dynamics:

"I think when I'm busy later, my younger sibling will ask me to play badminton. Even when it's raining, I think we can still do activities together." [PA0335]

Here, the student anticipates a shift in personal circumstances (being busier with studies) while simultaneously planning how to maintain family bonds. This illustrates scenario planning as a future-oriented process, where individuals envision different outcomes and create strategies to preserve meaningful relationships despite changing conditions. It echoes Amer Almishari's (2024) argument that scenario planning is not only about external risks but also about envisioning desirable futures and sustaining social well-being.

Another student described adjusting school activities when weather conditions prevent outdoor play:

"When it rains, we can't go outside to play football. Maybe I'll ask my friends to do homework, so we still have an activity even if we can't go out." [S0426]

This reflection demonstrates proactive adaptability, where the student plans an alternative activity (homework) to sustain engagement when usual routines are disrupted. As Hough et al. (2020) note, scenario planning allows learners to anticipate interruptions and adjust behaviours, ensuring continuity in productivity and social interaction. Within educational settings, such flexibility represents a practical manifestation of anticipatory competence, where students prepare strategies for both expected and unexpected shifts.

A further dimension of scenario planning was seen in students' reflections on their future roles in the community:

"If there's a big flood, we'll help, bring supplies for those affected. I think this will become more important when I grow older." [T0321]

This excerpt illustrates how students extend their foresight beyond personal routines to envision their contributions to society. They disclose anticipatory dispositions that incorporate empathy, responsibility, and civic engagement by imagining scenarios of natural disasters and preparing to provide assistance. Such perspectives align with sustainability education, where scenario planning is emphasised as a tool for fostering resilience and long-term preparedness in the face of environmental and societal challenges (Redman & Wiek, 2021; Mróz & Ocetkiewicz, 2024).

These findings resonate strongly with the literature on ATS, which frames scenario planning as a structured exploration of "what if" questions that enables learners to differentiate between probable, plausible, and preferable futures (Jones et al., 2012; Geden et al., 2019). The ANTA framework situates scenario planning as a complement to forecasting and risk assessment, highlighting its role in helping students develop flexible, adaptive strategies (Hiatt, 2023). By considering alternatives across family, school, and community contexts, the students in this study demonstrated that scenario planning strengthens not only individual resilience but also collective preparedness.

The students' reflections collectively demonstrate that scenario planning transcends mere abstract speculation; it is a pragmatic and relational process that empowers young individuals to sustain continuity in family life, remain engaged in education, and envision themselves as active participants in community welfare. According to Geden et al. (2019) and Hough et al. (2020), scenario planning improves flexibility and resilience, enabling individuals to adeptly manage many scenarios.

D. Opportunity Recognition

Opportunity recognition refers to the ability to identify favourable circumstances, even within challenges, and to leverage these moments for personal, social, or academic growth. In this study, students demonstrated opportunity recognition by reframing difficult or unexpected situations—such as heavy rainfall or natural disasters—into chances for learning, bonding, or contributing to their communities. This aligns with Geden et al. (2019), who argue that anticipatory thinking involves not only anticipating risks but also recognising and capitalising on potential opportunities. Similarly, Van Niekerk & Terblanché-Greeff (2020) notes that seizing opportunities is central to proactive action, enabling individuals to thrive even in uncertain contexts.

One student reflected on how adverse weather could be transformed into a productive academic opportunity:

"Maybe if there's a lot of rain, we can use that time to study together, helping friends who don't understand." [T0341]

Here, the student recognised that a potentially unproductive situation — being unable to go outdoors — could instead become a valuable learning opportunity through collaboration. This reflects the proactive reorientation that characterises opportunity recognition, where learners capitalise on available time and resources to achieve academic goals. Such insights resonate with research highlighting how opportunity recognition fosters resilience in education through collaborative learning and peer support (Ramadhani, Dafik, & Prastiti, 2023). In this case, the student reframes prolonged rainfall as an opportunity to study with friends, demonstrating specificity by articulating a concrete strategy to transform downtime into meaningful academic engagement (Geden et al., 2019). This proactive use of environmental conditions illustrates the anticipatory skill of turning constraints into opportunities for growth, underscoring the social and cognitive value of collaborative learning in uncertain contexts.

Another student demonstrated how social engagement can be maintained despite environmental constraints:

"Even though it's raining, I'll try to invite my friends to play video games. That's how we stay connected." [S0235]

This excerpt highlights opportunity recognition in the social domain, where the student identifies digital platforms as an alternative means to sustain friendships. Instead of viewing the weather as a barrier, the student reframes it as an opportunity for social bonding, exemplifying what Van Niekerk and Terblanché-Greeff (2020) describes as the proactive use of circumstances to maintain engagement and well-being. Within the ANTA framework, opportunity recognition is closely tied to adaptability, as it encourages individuals to identify and act upon resources that strengthen interpersonal connections in dynamic settings. By leveraging indoor leisure activities, the student demonstrates uniqueness, transforming a limiting condition into a social advantage (Geden et al., 2019). This creative reinterpretation of constraints reinforces the interpersonal dimension of anticipatory thinking, illustrating how students can sustain social engagement even in adverse contexts.

A further dimension of opportunity recognition was evident in community-focused reflections:

"If there's a natural disaster, we can help. That's an opportunity for us to be more useful to others." [W0262]

This student interprets crises not only as risks but also as opportunities for meaningful contribution, envisioning themselves as active agents of support in times of need. Such reflections align with research in sustainability education, which underscores the role of anticipatory competence in fostering social responsibility and collective resilience (Redman & Wiek, 2021; Mróz & Ocetkiewicz, 2024). The student demonstrates that anticipatory thinking extends beyond individual preparedness to incorporate empathy, collaboration, and civic responsibility by identifying opportunities for community engagement. Within the ANTA framework, this example illustrates remoteness, as the student projects beyond immediate circumstances to anticipate future crises and imagine long-term roles in civic participation (Geden et al., 2019).

These findings support the view that opportunity recognition is a critical but often overlooked dimension of anticipatory thinking. It reflects the ability to reframe adverse contexts into favourable ones, allowing learners to leverage the best available options even in constrained circumstances. As Geden et al. (2019) argue, opportunity recognition keeps individuals attentive to emerging possibilities, while Van Niekerk and Terblanché-Greeff (2020) stresses that seizing opportunities enables proactive action and long-term thriving. In this study, students demonstrated how opportunity recognition supports academic resilience, social connectedness, and community engagement, confirming its central role in cultivating anticipatory competence.

E. Adaptability

Adaptability emerged as a vital component of anticipatory thinking, as it reflects the ability to adjust plans in response to new information, disruptions, or changing circumstances. Students in this study demonstrated adaptability by modifying their routines and strategies to remain engaged and productive when external conditions shifted, such as heavy rainfall or competing family responsibilities. Geden et al. (2019) emphasise adaptability as central to managing uncertainty, while Hough et al. (2020) note that it enables individuals to sustain effectiveness in complex and dynamic environments.

One student explained how plans must shift when weather conditions change:

"If it rains heavily, we have to change our plans, just do indoor activities. We can't do outdoor activities." [S0223]

This response illustrates adaptability in action, as the student quickly shifts from outdoor to indoor activities when confronted with unexpected weather. This reflects specificity, given the clear and concrete alternative plan described (Geden et al., 2019). Such flexibility ensures continued productivity and engagement despite environmental disruptions.

Another student reflected on how family routines may be reshaped when time becomes limited:

"When I'm busy, maybe I can't go out with my family, so I will invite them to do other activities at home." [PA0338]

Here, adaptability is demonstrated through the reconfiguration of family interactions to sustain engagement despite time pressures. This highlights that adaptability is not limited to individual behavioural shifts but also involves negotiating relational adjustments that preserve social bonds (Van Niekerk & Terblanché-Greeff, 2020). The student adapts family routines by proposing indoor alternatives when outdoor activities are not possible, reflecting uniqueness in generating new strategies to maintain family interaction despite shifting circumstances (Geden et al., 2019). Such adaptability underscores the interpersonal dimension of anticipatory thinking, where preserving relationships remains a priority even when plans must be revised.

Adaptability was also apparent in the ways students sought out alternative leisure activities:

"If it rains, we'll stay indoors and do different activities like play video games." [N0232]

This student highlights adaptability by substituting outdoor routines with indoor leisure options. This demonstrates diversity, as the student generates multiple alternative activities to maintain engagement during disruptions (Geden et al., 2019). The willingness to shift not just once, but across different alternatives, underscores the flexible and resourceful nature of adaptive anticipatory thinking.

These findings align with broader research that highlights adaptability as a crucial skill for managing uncertainty and navigating complex environments (Hough et al., 2020). Within the ANTA framework, adaptability is situated as a dynamic element of anticipatory thinking, enabling individuals to adjust goals, plans, and behaviours while still remaining aligned with long-term objectives (Geden et al., 2019). Educational research further emphasises adaptability as a factor that strengthens resilience, fosters self-directed learning, and prepares students for professional and societal contexts where rapid adjustment is essential (Akhmetzyanova, 2016; He, 2022). The excerpts from this study illustrate how adaptability operates through concrete adjustments, the generation of novel alternatives, and the maintenance of diverse strategies. Taken together, these findings underscore adaptability as a core anticipatory skill, reflecting the interplay of specificity, uniqueness, and diversity that ensures students remain effective and resilient not only when facing immediate disruptions but also when navigating broader uncertainties in their academic, personal, and future professional lives.

The findings of this study underscore the significance of anticipatory thinking skills for secondary school students, revealing how learners actively engage in forecasting, risk assessment, scenario planning, opportunity recognition, and adaptability as part of their everyday lives. Students forecasted potential risks, particularly floods, by interpreting rainfall patterns and drawing on past experiences, demonstrating how foresight reduces uncertainty and supports proactive planning. Risk assessment was evident in their identification of environmental and infrastructural vulnerabilities, such as swamps, blocked drains, and low-lying land, illustrating their ability to evaluate hazards and anticipate consequences.

Scenario planning emerged in students' reflections on family routines, school activities, and community responsibilities, showing how they envisioned alternative futures and developed strategies for continuity. Opportunity recognition was expressed in their capacity to transform constraints into possibilities — turning rainy days into time for study, social connection, or community service. Adaptability tied these skills together, as students demonstrated flexibility in modifying plans and adjusting behaviours in response to changing circumstances.

Taken as a whole, these findings illustrate that Malaysian secondary school students possess a constellation of anticipatory competencies that prepare them to navigate uncertainty in personal, academic, and community domains. Consistent with the ANTA framework (Geden et al., 2019), the interplay of these skills reflects a future-oriented mindset that balances risk awareness with proactive engagement and opportunity-seeking. Integrating these competencies into educational curricula is therefore essential for equipping students to thrive in a complex and dynamic world, supporting both immediate learning outcomes and long-term resilience.

V. CONCLUSION AND RECOMMENDATIONS

This study set out to explore the anticipatory thinking skills (ATS) of Malaysian secondary school students, focusing on how they predict, prepare for, and respond to future events. Drawing on focused group discussions (FGDs), the study examined students' engagement with the five key components of anticipatory thinking — forecasting, risk assessment, scenario planning, opportunity recognition, and adaptability — particularly in contexts such as environmental challenges. The findings revealed that students demonstrated notable strengths in forecasting potential risks, such as flooding, by drawing on both past experiences and observable environmental cues. They were also able to assess risks by identifying structural and infrastructural vulnerabilities, envision

alternative scenarios for school, family, and community life, recognise opportunities for learning and social engagement even in adverse conditions, and adapt their plans flexibly in response to shifting circumstances.

These findings underscore that anticipatory thinking is not a singular skill but a constellation of interrelated capacities that enable students to make sense of the present while preparing for uncertain futures. Within the ANTA framework (Geden et al., 2019), students' responses reflected the evaluative qualities of specificity, uniqueness, remoteness, and diversity, demonstrating that their anticipatory practices can be systematically understood and cultivated. By linking these evaluative dimensions to lived student experiences, the study provides both theoretical and practical insights into how anticipatory competence develops in adolescence.

Importantly, the results point to clear implications for teaching and curriculum development. Embedding forecasting into science or geography lessons can help students interpret data and predict outcomes; using risk assessment tasks in civic or project-based learning can foster proactive problem-solving; scenario planning activities, such as simulations, can train students to envision multiple futures; encouraging opportunity recognition can cultivate entrepreneurial and problem-solving mindsets; and strengthening adaptability through reflective practices can prepare students to respond flexibly to change. For teachers, this requires moving beyond rote instruction toward approaches that nurture creativity, resilience, and foresight. Professional development programmes may also equip educators with tools to design anticipatory activities and evaluate progress using frameworks such as ANTA. At the policy level, incorporating ATS into national education standards would align Malaysian schooling with global 21st-century competencies.

Looking forward, future research could adopt longitudinal designs to examine how ATS develop over time, particularly as students transition from secondary schooling into higher education or the workforce. Comparative studies across educational systems would further illuminate the socio-cultural factors that shape anticipatory skills, while investigations in broader domains such as career planning and interpersonal relationships would extend understanding beyond disaster contexts. Expanding this research to include both younger and older learners could also provide a developmental perspective on ATS growth across educational stages. By fostering anticipatory thinking systematically, educators can equip students with the foresight and flexibility needed to navigate uncertainty, seize opportunities, and contribute meaningfully to society in an increasingly complex world.

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