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Towards Equity: Exploring Gifted and High Achieving Students' Lived Experiences with a Mathematical Enrichment Program Based on PISA

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Abstract: The purpose of this research was to study the effectiveness and usefulness of a Mathematics Enrichment Program (MEP) from students' perspectives. The case study presented in this paper highlights the need for the MEP as a possible way to fulfill the needs of high-achieving and gifted students in mathematics in regular classrooms. This MEP was designed to improve students' mathematical literacy in relation to their readiness for work after school and using mathematics in real life. The process for developing the MEP was described. The sample consisted of 51 grade 10 students from the advanced stream in two high schools in the UAE. Quantitative and qualitative data were collected through a survey designed specifically for this study to gain insight into students' perceptions of their participation in the MEP experience. Students' responses to the survey showed a significant impact of the enrichment program on them in many aspects. It is evident that this program helped the students see the importance of mathematics in their life. Although participants reported excitement and more understanding of their mathematics classroom, a few students complained about the of lack of time and difficulty with language and problem-solving skills.

Keywords: Mathematics Enrichment Program; students' experience; high-ability learners; problem solving; PISA

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1. Introduction

The focus of educational policy has recently begun to shift from completing compulsory education to ensuring quality education that will develop students to be ready for international competition. Likewise, one of the main pillars of the United Arab Emirates (UAE) National Agenda is to improve students' competencies and abilities in diverse literacy skills in reading, mathematics, and science by developing an ideal and high-quality educational foundation [1]. The Program for International Student Assessment (PISA) examines the students' ability to use mathematics to think about their lives, make plans for their future, and think about important problems and issues in their lives. Recently, the PISA results revealed a challenge for the UAE. The UAE students ranked in the 50th position in mathematics out of 79 countries in PISA 2018 [2]. Although Emirati students in PISA 2018 were leading the Arab countries as they scored the highest average performance in mathematics literacy compared to students of other Arab countries, the results indicated poor performance in general. PISA measures proficiency on a scale of one to six, with level 1 being the lowest. Only approximately 5% of UAE students can perform at the fifth and sixth levels, and nearly half of the students in the UAE still achieve below Level 2 [3].

One of the factors that cause PISA scores to drop is that students are not trained to solve contextual problems [4]. Most students have experienced "doing mathematics" which involves studying materials and working through abstract tasks. In contrast, PISA problems can be considered as one of the measures that address current social needs, focusing on students' ability to solve real-life problems faced in modern society [5]. PISA problems are contextual in nature and are presented as word problems. Based on the literature, some reasons have been suggested to answer the question of why students are not very successful in solving word problems: first, students have limited experience with word problems [6]; second, lack of motivation to solve word problems [7]; and third, word problems were irrelevant to students' lives [8]. This suggests that it is imperative to provide students with opportunities to become real-life problem solvers by exposing them to the type of problem that develops their problem-solving abilities [5].

Although remedial actions must be taken to help all students improve their learning levels, high-achieving students receive little attention despite their critical role in developing and transforming societies [9]. Long ago, in 1980, An Agenda for Action: Recommendations for School Mathematics stated that "outstanding mathematical ability is a precious societal resource, sorely needed to maintain leadership in a technological world" [10]. However, the discourse on equity focused primarily on providing access to a minimum of basic mathematics but ignored the high potential among disadvantaged students [11]. According to the Diversity in Mathematics Education Center for Learning and Teaching (DIME) [12], many countries report equity and learning opportunities primarily for low-achieving students and their chances of having some access to basic mathematics. Only recently, research and development have focused on the potential among underprivileged students, those who are not immediately identified as having high potential [11,13]. The "mathematical potential" construct is used for students "who can achieve a high level of mathematical performance when their potential is realized to the greatest extent" [14]. There is a call for a wider conceptualization of mathematical potential due to the economic demands raised by the huge need for STEM academics in a technical civilization. This concept of "mathematical potential" can be carried over from the top 2% to a wider group of about 20% of all students, and thus they are less exclusive than the usual "talented" or "gifted" [11].

The findings of a recent study by [15], which used the PISA framework to evaluate pupils' mathematical literacy, were in line with those of the OECD [3]. The results revealed that students are comfortable addressing mathematical literacy problems at the low levels of 1–3 but struggle with problem-solving that requires higher-order thinking and reasoning problems at levels 4–6 where they scored only a 9% accuracy rate for level 4 questions, 5% for level 5, and only 2% for level 6. This suggests that there is a genuine need for intervention to raise these levels, particularly the performance of gifted and high achievers who can function at levels 5 and 6.

Teachers should raise expectations when interacting with high-achieving students so that they can compete to their potential. Because if students fail to reach their potential, it is a loss, not only for the students but for the nation too. Therefore, an enrichment method was applied to improve the poor performance of high-achieving students in the form of a mathematical enrichment program (MEP). In addition, it was found in a previous study that mathematics teachers reported the lack of specialized mathematics programs for gifted students in the UAE [16]. Thus, the current research provides novel and crucial insights concerning gifted programs. The impact of the enrichment program on the student's knowledge of mathematics has been studied in previous studies [17]. Therefore, the main purpose of this research is to study the students' enrichment intervention experiences and how this enrichment program affects students' learning from their point of view. This will help with upcoming planning and considerations for PISA 2025 and subsequent cycles as well as provide the gifted and high-achieving students with a program to reach their potential and gauge their readiness for their future life.

2. Literature Review

2.1. What Is Enrichment?

The Cambridge Dictionary [18] defines "enrichment" as "the act or process of improving the quality or power of something by adding something else" (para. 1). Enrichment is defined as any type of activity or learning that falls outside the core of the learning that most children do. The goal of enrichment is related to improving the quality of life in the classroom and increasing sensitivity [19]. The authors of [11] stated that enrichment means exposing the students to rich learning processes to expand their experiences and skills. However, enrichment is considered a relative concept as all definitions refer to normal practices that are not standardized in schools and classes [20]. Nevertheless, the enrichment curriculum will provide students with the opportunity to experience "the joy of confronting a novel situation and trying to make sense of it—the joy of banging your head against a mathematical wall, and then discovering that there may be ways of either going around or over that wall" [21].

Feng [20] points out that enrichment is a way to introduce accessible aspects of mathematics not covered by the curriculum, promote mathematical reasoning, encourage extended problem-solving, provide alternative approaches to curricular topics, and highlight links between aspects of mathematics presented separately in the curriculum. Thus, enrichment should not only be available to the fastest and brightest students but it should also be integrated into the curriculum. Moreover, enrichment is not only seen as a means for more capable students, but all students will also benefit from it; at least it can offer most students a more realistic option for classroom management [22].

The "enrichment of content" was defined as "any learning experience that replaces, supplements, or extends instruction beyond the restrictive bonds and boundaries of course content, textbook, and classroom and that includes depth of understanding, breadth of understanding, and relevance to the student and to the world in which he or she lives" [23]. In the same vein, ref. [22] focuses on depth, breadth, and relevance as major components of enrichment. To this end, there are two types of enrichment: obtained either through broadening or deepening. Enrichment through broadening represents learning additional topics rather than what is normally studied at school, while enrichment through deepening enhances the depth and complexity of the subject being studied in the school [11].

For the mathematics education field, enrichment is defined as "broadening students' mathematical experiences by examining mathematics outside of the prescribed curriculum and also making connections with other curriculum areas" [24]. Additionally, enrichment in mathematics means allowing the learner to learn mathematics in more depth to expand the learner's knowledge [25]. Enrichment through deepening the tasks and topics is mostly selected because it is in line with the regular curriculum unlike broadening through extracurricular activities [26]. For this study, the definition of enrichment as deepening and expanding students' knowledge is chosen because it suits the needs of high-achieving students in regular classrooms through an emphasis on problem-solving and mathematical reasoning [22].

2.2. Paradigmatic Positions of Mathematics Enrichment

The enrichment activities aim to provide students with a stimulating mathematical experience, promote positive attitudes, raise the level of achievement, and contribute to efforts to enhance, generalize, and increase the general understanding of mathematics. From the enrichment literature, four paradigmatic positions can be identified to reflect educational views and priorities; Feng [20] listed enrichment positions as follows:

- Development of exceptional mathematical talent (e.g., [27]);
- Popular contextualization of mathematics (e.g., [28]);
- Enhancement of mathematics learning processes (e.g., [22]); and
- Outreach to the mathematically underprivileged (e.g., [29]).

According to Feng [20], the first position is directed to few students, only the gifted, as it aims to identify and develop mathematical talent. The second position applies to all students where the focus is on the application of mathematics as a means of engaging students in mathematics. This will make students appreciate the applications of mathematics in life, and not just as an academic discipline. This is expected to break the negative stereotypes of mathematics by deepening students' understanding of mathematics and its applications [20]. The third position of enrichment is an approach to the ongoing process that should infuse all aspects of teaching and learning as an integral part of education for all students, whether in regular classrooms or beyond that is best described as student- and experience-centered [20]. The fourth position calls for social justice and equity; educators who support this view not only believe that enrichment should be open to all students, but also make proactive efforts to ensure mathematics enrichment for students who have not traditionally benefited from such provisions [20]. All of these mathematics enrichment positions are motivated to provide high-quality mathematics learning experiences. However, opposing views arose from differing perceptions of how to best achieve this and to whom it should be applied to achieve the most benefit.

The focus of this study is mainly on the third position to enhance the mathematics learning process while using contextual mathematics which will also lead to the satisfaction of the second position of enrichment as popular contextualization of mathematics. According to Feng [20], "using this interpretation of enrichment, the engagement of all students in meaningful mathematical practices is an essential and worthwhile part of education; this also forms the main goal of mathematics enrichment". Enrichment tasks are often designed to use mathematical concepts and techniques at various levels of difficulty and may lead to qualitatively different endpoints [20,22]. If mathematics enrichment includes "mathematical problem solving and mathematical logic linked to mathematical contexts" [22], enrichment should be the basis for many, if not all, aspects of the curriculum, and all students should be able to benefit from this experience [20].

2.3. Mathematical Enrichment Content Framework

In this study, enrichment by deepening was adopted based on problem-solving and mathematical reasoning [22]. The problem-solving content entails the general scope of skills that can be applied both inside and outside of mathematics curricula [22]. Therefore, real-life applications can be incorporated into problem-solving to engage students in mathematics. Mathematical thinking is associated with specific mathematical skills that need to be drawn on for effective problem-solving. This enrichment program integrates PISA contextualized problems into its content that require thinking at a higher level, such as mathematical thinking [30]. Looking at the PISA 2021/2022 framework, the mathematics content is referred to as mathematical literacy that also covers problem-solving and reasoning [31,32]. Moreover, the components of mathematical literacy include mathematical thinking, such as reasoning and modeling [33]. These elements then work together and interact with both teachers and students as shown in Figure 1 [22].

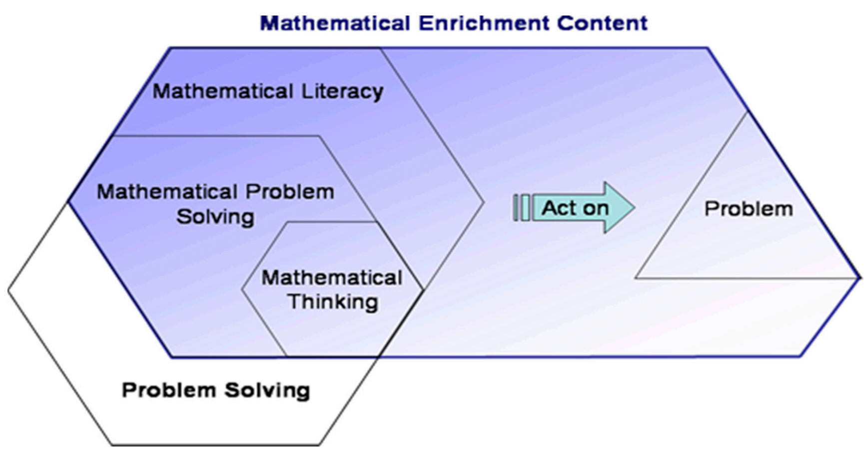

Figure 1. Mathematical Enrichment Content Framework.

PISA 2021/2022 [31,32] and Piggott [22] agree that learning general problem-solving skills will not suffice when teaching about problem-solving. Students also need mathematical thinking skills, because without them they would not have the skills to apply them to the problem-solving process. The reasoning is central to problem-solving (modeling processes) based on PISA 2021/2022 framework.

PISA aims to measure the students' mathematical literacy that focuses on real-world problems as the students encounter situations and problems that go beyond what was learned in the school's classroom [34]. Students are required to use the skills and competencies they acquired through their school learning to solve these contextual problems [34]. However, school mathematics curricula are usually structured into topics that focus on procedures and formulas. Mathematics is presented to students as a set of disjointed pieces of factual knowledge, not as overarching concepts and relationships [34]. Because of this organization, students may not be able to see or experience existing mathematics in new fields and applications [35].

For this content to make sense, learning and teaching environments need to encourage the effective use of resources so that students can develop the skills, strategies, and competence needed to effectively address problems and use basic thinking skills [22]. A specific view of teaching and learning supports engaging problems that develop and use problem-solving strategies and encourages mathematical thinking. Thus, teachers can apply Contextual Teaching and Learning (CTL) which is a method that helps the teachers relate subject content to real-world applications and motivate students to make connections [36,37]. There are several connections between the CTL steps and components of learning with indicators of mathematical literacy abilities [38]. Hence, mathematical literacy could be improved through the application of contextual learning.

This CTL approach reflects the constructive perspectives of learning through social interaction [39]. Constructivism emphasized, as a learning theory, the role of students rather than that of the teacher. In constructivism, students can use their prior knowledge and experience in testing ideas and apply these ideas to a new situation [36]. Learning aims to provide learners with learning situations to assimilate new learning together with prior knowledge to construct their unique cognition [40]. However, Swan [41] stressed the crucial role of students' collaboration, building on the knowledge that students previously studied, and creating tension and cognitive conflict to be resolved by drawing on collective knowledge and discussion for multiple solution pathways. Non-routine problems let the students think of more than one solution and use more than one strategy. While the students work together and use their prior experience to gain new information in the process of problem-solving, the teacher's role is to facilitate this collaboration.

2.4. Significance of the Study

This study describes the process of developing the MEP. Findings from this study are expected to serve a larger goal of informing mathematics leaders in the UAE on how to improve students' mathematical literacy. Moreover, researchers in the UAE and similar-level countries may build on the results of this study to help them shape future education. This study could be replicated at different levels. Additionally, it could also help in meeting the needs of gifted students because although intervention procedures must be taken to help all students improve their learning levels, high achievers receive little attention despite their critical role in developing and transforming societies.

This study sought to answer the following research questions to learn about the students' lived experience of participating in the MEP:

1. What are the students' perspectives regarding participating in the MEP program based on the PISA framework?
2. Did the students feel that the mathematical enrichment program was beneficial or not? In what aspects?

3. Methodology

The purpose of this research was to study the effectiveness and usefulness of the MEP from the students' perspectives. The following research methodology is that of the evaluation research [42]. Evaluative research should enhance knowledge and decision-making and lead to practical applications. This case study of evaluating MEP went through two phases: the planning and implementation phase and the evaluation phase [43]. The purpose of the first phase of the case study was to give an opportunity to students to learn more about the enrichment program. The authors of this study have developed the MEP content. Students and parents were briefed on the nature of the MEP program and its gained benefits, such as the development of academic skills in mathematics. Participation in this program was voluntary, and no extra marks were given to students. Students engaged in real-life problem-solving that was new to them, and that was based on the PISA framework. The teacher's role was to facilitate students' construction of mathematical knowledge, support and expand student thinking by fostering discussions, and encourage students to develop their own problem-solving strategies and use informal or prior knowledge to help develop their conceptual understanding and use of alternative solutions methods.

The purpose of the second phase was to evaluate the effectiveness of the MEP. The evaluation process for the case study was twofold: to assess the impact of the study on the students' mathematical literacy and to capture the students' perspectives on the MEP. Previous research studied the impact of the enrichment program on the student's mathematical literacy [17]. The researchers in this study applied a quasi-experimental method. The applied mathematical enrichment program showed a positive impact in improving the students' mathematical literacy. The results revealed that there were statistically significant differences between the experimental and control groups in favor of the experimental group, in which female students recorded a greater improvement than males. For capturing the students' perspectives, a survey developed specifically for this study was distributed to all participants as a hard copy to ascertain students' impressions immediately after completing the MEP. Students' opinions were recorded in two ways, first through the quantitative portion of the survey, and second through the qualitative portion of the survey to gain a deeper understanding of the MEP experience.

To this end, the phenomenological mixed method was considered appropriate since it would allow participants to describe their lived experiences. Mixed-methods research was defined as "research in which the investigator collects and analyses data, integrates the findings and draws inferences using both qualitative and quantitative approaches" [44]. In addition, the authors in [45] stated "a phenomenological study describes the meaning for several individuals of their shared experiences of a concept or a phenomenon" (p. 57). The method used in this study was based on a quantitative and qualitative (QUAN-Qual) model that is also known as an explanatory mixed-methods design [46,47].

3.1. Participants

The sample selection technique was the convenience sampling method. The participants of this study were 51 grade 10 advanced stream students from 2 schools. In addition, 27 (51%) were males, and 24 (49%) were females. In this study, participants were selected from a wide range of gifted and talented students out of 20% of the top students. No strict criteria were applied to select study participants from among the top 2% of students, but they were selected from the grade 10 advanced stream as most students choose this stream due to their potential to be among the top 20%. The advanced stream was the focus of this study because it is chosen in the UAE by the students who excel in mathematics and other subjects. Therefore, it makes sense that these top students would exist more in these classes. In addition, most 15-year-olds fall into grade 10 as the MEP is built based on the PISA framework and is oriented to their age period.

3.2. The Instrument

The mathematical enrichment program (MEP) is a teacher-directed program where the role of the teacher is to provide appropriate tasks, create an atmosphere in which students are not passive by making mathematical connections, and help them bridge knowledge gaps [22]. A "good" problem structure requires students to interact and build solution plans, revisit ideas, relate closely to building on prior knowledge, and build mental patterns associated with a rational view of the knowledge [22].

3.2.1. The Proposed MEP Development Principles

Based on the previous literature and the related studies, the following principles were identified to underline the development of the proposed enrichment program to improve the students' mathematical literacy.

- It is designed to build on students' prior knowledge [40].
- It is based on contextual problems that address the modeling problems that improve higher-order thinking skills (problem solving and reasoning) [22,32].
- It consists of PISA problems of different levels to ensure that the problem levels are at the appropriate cognitive level for students [32].
- The teacher's role is to facilitate students' construction of mathematical knowledge and support and expand students' thinking [5,48].

3.2.2. The Content of the Proposed Enrichment Program

This proposed MEP aimed to improve the students' mathematical literacy. Nevertheless, mathematical literacy is a very broad and cumulative area. Therefore, the scope of content for this enrichment program was identified to be restricted to the comprehensive framework of mathematical literacy in PISA. The main components of mathematical literacy involve mathematical thinking such as reasoning, modeling, and making connections between ideas [33].

The development of the MEP relied mainly on two components, which were a review of the basics of prior knowledge required for each lesson as well as the relevant PISA items released. The PISA items were chosen because they are appropriate to the cognitive level of the participants and were designed to test students at the age of 15. The researchers revised all the released items based on the PISA's four "overarching ideas" and compiled them into two main lessons. Therefore, this proposed enrichment program consisted of eight lessons covering four PISA "overarching ideas" [49]: "change and relationship", where the students can model change and relationships with the suitable functions and equations; "space and shape", in which students understand perspective, create and read maps, and manipulate 3D objects; "quantity", in which 15-year-olds can understand multiple representations of numbers, participate in mental arithmetic, use estimation, and assess the reasonableness of results; and "uncertainty and data", where students use probability and statistics and other techniques of data representation and description to mathematically describe, model, and interpret uncertainty (pp. 33–35). PISA problems are presented as units and each unit is composed of items of different levels (see Appendix A, for example).

Two lessons were developed to address each of the four content areas. Every lesson was developed based on the most addressed topics from the released PISA items of different levels in addition; these released items were collected to build on students' prior knowledge. In addition, addressing reasoning was embedded in these four content areas as the processes of solving these problems might require formulating, employing, and interpreting in which reasoning was essential to all these processes. The proposed timeline for the MEP is presented in Table 1.

Table 1. Enrichment program content and time range for lessons.

Content Areas	Lessons	No. of Sessions
Change and relationship	Functions and variations	2
	Numerical trends and patterns	2
Space and shape	Geometric approximation	2
	The visual and physical world	2
Quantity	Percentages	2
	Quantification	2
Uncertainty	Probability	2
	Statistics	2
Total	8 lessons	16 sessions

As shown in Table 1, the allocated time for each lesson was two periods of 45 min. The lesson time for the mathematics subject may be used to enable all students to participate in this type of provision or at any other available time. Only one lesson was discussed each week. As a result, eight weeks were required to implement the enrichment program.

3.2.3. Appropriateness of the Proposed Enrichment Program

The development of the enrichment program took several steps to reach its final form. For judging the appropriateness of the proposed MEP, it was presented to a group of experts who have experience in teaching and learning mathematics. The group of experts consisted of one professor in mathematics education, one professor in mathematics, and five expert mathematics teachers. Experts indicated that using the PISA-released items was appropriate to grade 10 students' cognitive level as it was designed to test this age range. According to Piaget's theory of constructivism, students of this age are in the operational stage where they are cognitively capable of reasoning and solving problems [50]. They also mentioned that this enrichment program included problems that might challenge most levels of students in addition to the most important prior knowledge that was necessary for every lesson.

3.3. The Perceptions Survey

This survey was designed by the researchers specifically for this study to gain insight into students' perceptions of their experience in the MEP. The survey consisted primarily of three sections. The first section consisted of one item of a yes/no response to indicate whether the students would recommend the program. The second section was dedicated to evaluating the program with 8 items on a 5-point Likert scale. Finally, the third section was an open-ended question type that represented the qualitative part of the survey. It aimed to provide students with the opportunity to express their opinions about their personal experiences and to highlight and clarify their ideas. Open questions were used to help validate and strengthen quantitative research results by identifying patterns that emerged during data collection. After collecting and analyzing data about the student's perceptions, the reliability of the perceptions survey was calculated. Cronbach's alpha, the most common measure of scale reliability, was used to calculate reliability and was found to be 0.94, indicating a high-reliability [46,47].

The perceptions survey was analyzed after it was distributed to all participants. The descriptive analyses were used to analyze the quantitative part of the survey. For the qualitative part, thematic content analysis was used to identify the emergent themes [51]. Similar patterns in the data were identified, categorized, and then placed under specific themes. This process was done by one researcher independently and then repeated by the third researcher to improve the credibility of the results.

4. Results

4.1. The Results of the Quantitative Part of the Perceptions Survey

Firstly, students were asked if they recommend the MEP to other students. The program was recommended by most students where forty-four (86.3%) recommended it, while only seven students (13.7%) did not recommend it (five males and two females). Secondly, for the eight items, statements, on the 5-point Likert scale, descriptive statistical analyses were employed; mean scores rather than total scores were analyzed, following Gagné's interpretations [52]. The mean scores were categorized as follows: mean scores of 4–5 points were classified as high positive (HP), 3.24–3.99 as positive (P), 2.75–3.25 as ambivalent (A), and 2–2.74 as negative (N). Scores under 2 were considered high negative (HN). The means and standard deviations of the results for individual statements in the survey were found. In addition, the mean results per individual statement rating were estimated using Gagné's interpretation as demonstrated in Table 2 [52].

Table 2. Perceptions Survey Mean Scores.

Program Evaluation Survey Items	M	Rating
1-I loved the mathematical contextual problem solving presented in this program.	3.80	P
2-This program made me feel more confident about my mathematics ability.	3.92	P
3-This program helped me to do better in my regular mathematics class.	4.06	HP
4-This program made me see and appreciate the importance of mathematics in life.	4.18	HP
5-This program made me more motivated and engaged in my mathematics study.	3.86	P
6-This program made me more prepared to take the PISA test in mathematics.	4.20	HP
7-It is important to spend time studying contextual problem-solving.	4.10	HP
8-Deducting time from math classes to implement this program did not present a challenge to complete the required curriculum on time.	2.90	A
Survey Average	3.88	P

Table 2 reveals that students showed a general positive feeling (M = 3.88) about the program. They were very positive about four aspects of the program: it made them more prepared for the PISA test (M = 4.20), it made them see and appreciate the importance of mathematics in life (M = 4.18), they see that spending part of mathematics classes time to study this type of problems is important (4.10), and they see that the program helped them do better in their regular mathematics classes. The students were positive about three aspects of the program: they loved the mathematical contextual problems (M = 3.80) that made them more confident in their mathematical ability (3.92) and motivated them to learn mathematics (M = 3.86). Noteworthy, the students were only ambivalent (M = 2.90) about taking time from mathematics classes to implement the program.

An independent-samples *t*-test was conducted to compare the perceptions towards the program for female and male students. For homogeneity of variance, equal variances were assumed based on Levene's test of equality of variances (F = 0.093, $p = 0.762$). The independent *t*-test was performed, and its results are shown in the following Table 3.

Table 3. Comparison of female and male perceptions about the MEP.

Variable	Female (N = 24)		Male (N = 27)		T	df	*p*
	M	SD	M	SD			
MEP perceptions	4.03	0.74	3.74	0.84	1.306	49	0.198

Table 3 shows that there was no statistically significant difference between female (M = 4.03, SD = 0.74) and male students (M = 3.74, SD = 0.84) on program evaluation ($df = 49$, $t = 1.306$, $p > 0.05$). The researcher failed to reject the null hypothesis. However, female students showed a better mean value, which is not surprising given that in previous research examining the impact of MEP on students' mathematical literacy female students also recorded greater improvements compared to male students [17].

4.2. Results of the Qualitative Part of the Perceptions Survey

Students were asked one open-ended question to explain how they felt about their experience as follows: "Do you feel that the MEP helped you or not? In what Aspects?". The students reported 42 (82.4%) positive comments about the program versus 9 (17.6%) negative comments. All students' comments had been reviewed and were then classified into themes. Themes of positive comments were about "More Understanding", "Mathematics in Life", "Preparing for PISA", "Excitement", "Review", "Discussion", and the last category was "Yes" without comments, while the rest of the comments fell into three negative themes. Themes of negative comments were about "Time", "Problem language", and "Problem-solving". Tables 4 and 5 show the number of comments and some examples represent the emergent positive and negative themes respectively.

Table 4. Positive themes of students' comments.

Theme	N	Examples of Positive Comments
More Understanding	14	"Yes, it helped me to understand school topics." S3 * "I understood the mathematics concepts better and differently, now I got it." S7 "The time taken from class to study this program was good, I used the program information in the mathematics periods." S8 "It broadens my understanding of mathematics." S4
Mathematics in life	6	"This program makes me see the importance of mathematics in life and not to study only equations." S6 "It showed me applications of mathematics in life." S9 "It is very useful and could answer many questions in life." S1
Preparing for PISA	6	"Yes, I think I can now take the PISA test well because I am the first time to know about it through the exercises of this program." S3 "It helped me to know about PISA, I liked this kind of problems, it makes me feel like this is the real math not only the formulas that we learn and use." S8 "Yes, it helped me a lot, for example, increased my self-confidence in solving math problems, and also helped me to know the way the questions of the PISA exams." S9
Excitement	6	"It makes me excited about the tricks, I never thought of mathematics in this way." S10 "It's fun and makes me love math." S12 "It was exciting, even when I don't understand the meaning for every word in the question, I tried to understand the question and tried to solve it and I succeeded many times." S22
Revision	3	"Yes, the revision part was very important because it is the basics that help in solving the story problems." S41 "The program covered all mathematics we learned." S33 "I liked it to make me revise previous math concepts." S27
Discussion	2	"Some questions challenged me; I liked spending time discussing these questions with teacher and colleagues." "I am excited in these classes; I like the discussion with my teacher and friends." S39
With no comments	5	"Yes." S44 "Yes, it helped me." S50

* Student number.

Table 5. Negative themes of students' comments.

Theme	N	Examples of Negative Comments
Time	3	"No, because time is not enough." S49 * "It is not part of the curriculum, why should we waste time." S35 "It needs more effort and time because sometimes we don't study the same things we study from the book." S15
Language of problem	3	"Not too much. I don't understand the question, the words are very hard and make me feel nervous." S16 "No, I don't understand this kind of problems there are many difficult words." S9 "No, I can't understand these questions." S10
Problem-solving skills	3	"I don't like these questions; I can't understand how to solve them." S16 "I don't like it because I don't like this kind of math because I don't know how to solve it." S41 "I don't like it because I don't like story problems. it needs more efforts to understand what method to use to solve it." S49

* Student number.

Table 4 shows the themes regarding positive students' comments and presents these comments in seven groups resulting in six themes. Students generally held positive impressions about the impact of the program. Students reported 14 comments representing the most positive theme of "More Understanding" indicating the impact of this program on increasing their understanding of the curriculum. The three themes of the positive responses were "Mathematics in Life", "Preparing for PISA" and "Excitement" with six positive comments each. The last two topics on "review" and "discussion" were in three and two comments, respectively, while five comments expressed students' positive feelings about the program without explanation.

Table 5 reveals that negative responses were divided into three main themes: "Time", "Language", and "Problem-solving". The "Time" theme indicates that students didn't like taking part in mathematics classes for the program implementation. The "language" theme mainly reflected the students' feelings about the difficulty of words which results in a misunderstanding of the question. Some students were struggling at deciding how to solve the problems as presented in the "Problem-solving" theme.

The qualitative results of this research strongly supported and explained the quantitative results. Students' responses to the second part of the survey generally yielded four very positive responses and three positive responses, while responses to only one statement reflected an ambivalent feeling about the program. The highest positive response in the survey was that the MEP made the students more prepared to take the mathematics PISA test ($M = 4.20$). This statement was supported by six positive comments that fell under the theme "Preparing for PISA" as one of the representative comments was "Yes, I think I can now take the PISA test well because I am the first time to know about it through the exercises of this program." The second very positive response in the survey was about appreciating the importance of mathematics in life ($M = 4.18$). There were six positive comments in the "Mathematics in Life" theme that support this view. One of the comments was "This program makes me see the importance of mathematics in life and not to study only equations." These comments reflected the important role of mathematics in life, which was more than just studying abstract and separate topics from life.

The students' responses to the importance of spending time studying contextual problem-solving in mathematics were the third most positive views ($M = 4.10$). This might be also reflected by the six comments in the "Mathematics in life" theme and another two responses in the "Discussion" theme such as "I am excited in these classes; I like the discussion with my teacher and friends."

The responses were also very positive to the survey item: "This program helped me do better in my regular Mathematics class" (M = 4.6). In addition to the positive responses to the survey item: "This program made me feel more confident about my mathematics ability" (M = 3.92). Both survey items were reflected hugely by comments on two positive themes: 14 comments in the "More Understanding" theme such as the comment "I understood the mathematics concepts better and differently, now I got it" and three more comments in the "Revision" theme, for example, "The program covered all mathematics we learned." Students also demonstrated positive feelings about another survey item "This program made me more motivated and engaged in my mathematics study" (M = 3.86). This statement was supported by six positive comments in the "Excitement" theme such as "It makes me excited about the tricks, I never thought of mathematics in this way." Any of the previous themes and positive comments could explain the students' positive rating of the statement "I loved the mathematical contextual problem solving presented in this program" (M = 3.80). Therefore, overall, the students loved this MEP.

However, the students held an ambivalent feeling towards how time was used to implement this program as their responses indicate this survey statement "Deducting time from math classes to implement this program did not present a challenge to complete the required curriculum on time" (M = 2.90). This was reflected by three negative comments in the "Time" theme where these comments about the students' benefit from the program were as follows: "No because time is not enough", "It is not part of the curriculum, why should we waste time", and "It needs more efforts and time because sometimes we don't study the same things we study from the book". These comments reflected some students' rejection of the program because they perceived it as "a waste of time" and repetition of their previous study or because they didn't have enough time, while two more themes explain the students' rejection of this program where three negative comments fell in the "Language of problems" theme such as "Not too much. I don't understand the question, the words are very hard and make me feel nervous". This indicated the difficulty faced by students regarding the understanding of the word problems in general. In addition to another three negative comments that fell in the "Problem-solving process" theme, the students indicated their inability to decide how to solve the word problem with statements such as "I don't like these questions; I can't understand how to solve them."

5. Discussion

Students' responses to the survey of self-reported perceptions showed an overall very positive impact of the enriched mathematics program on students in many aspects. Most of the students reported that they have more understanding of their mathematics classroom. Students need to deepen their understanding of the mathematics that they are learning in the classroom. It is not expected of students to just practice and memorize the mathematical knowledge that teachers provide. The learning process today is "student-centered" where students favor discovering new ideas for themselves [53]. Additionally, students expressed their excitement to be involved in this program. Students felt more prepared to ask questions and engage in discussions with their teachers and colleagues. The student is not 'an empty vessel' to be filled with knowledge [54].

In this research, enrichment was provided for a wider range of gifted and high-achieving students, therefore, the diversity of students' levels was considered as it provided problems of different levels of mathematical expertise to students. PISA problems are presented as units of different question levels. Foster [55] pointed out that an appropriate "ramp" to the task allows the students to immediately think of something to do to solve the problem. Even though the solution might not be obvious to the learners, it is a difficulty that also should not be experienced as threatening. If the start point of a problem is beyond the student's zone of proximal development [56], then the student cannot engage with the problem, and it will not result in a learning gain no matter what the amount of support was. Furthermore, a relatively easy beginning to the solution is not the end itself, it only helps students to get "into" the problem and is a step towards appreciating and confronting the larger task [55]. Moreover, this allows students to achieve some early success, which means positive engagement that motivates learners [55].

Although word problems such as mathematical contextual problems recently exist in all mathematics curricula, teachers continue to ignore them for many reasons such as lack of time to search and apply appropriate contextual problems due to the intensive curriculum. This enrichment program allowed the students to be exposed to different kinds of PISA problems and develop problem-solving skills. This program was an eye-opening experience for the students on what kind of problems the PISA problems are. As a result, participants of this program reported that they are more confident to solve contextual problems and they are now more prepared for PISA international test.

6. Conclusions

Finally, it is evident that this program helped the students see the importance of mathematics in their life as reflected in the results of the survey. Students are no longer required to only memorize formulas, but they must understand their applications and the meaning beyond their parts. Learning aims to provide learners with learning situations to assimilate new learning together with prior knowledge to construct their unique cognition [40].

6.1. Limitations

This study, which was carried out in the city of Al Ain, Abu Dhabi, was limited to collecting survey data from students to assess the enrichment mathematics program. Because most 15-year-olds are in the 10th grade, the study was also limited to students in this grade. Additionally, the study's focus was limited to the advanced stream to study the gifted and high-achievers' experiences in the enrichment mathematics program.

6.2. Implications and Future Research

Evaluative research should enhance knowledge and decision-making and lead to practical applications. As such, and based on students' experience, it is recommended that policy makers devote formal time to implementing similar programs that present contextual problems to support mathematical literacy skills in schools. Leaders in mathematics education, such as the National Council of Teachers of Mathematics (NCTM) [54] and Common Core State Standards Initiative [57], call for more focus on mathematical problems based on real-life situations that promote mathematical modeling and quantitative reasoning. Thus, researchers, teachers, and curriculum designers need to continue their efforts to support the use of contextual problems and their roles in students learning. The implications of the study results for curriculum design are to include contextual problems in the curriculum regularly.

Additionally, the NCTM [54] indicated that assessment and education should be complementary so that the assessment provides information for the teacher to use in making educational decisions. If the test does not contain sufficient elements of the difficulty appropriate for the student, the result may not indicate the true level of his understanding [58]. Thus, it is necessary to apply high-level assessments that have more difficult elements of achievement tests at the grade level.

Research indicated that the implementation of the enrichment program will require three components: a dedicated teacher, appropriate content, and an eager student who will participate in the enrichment study [43]. Accordingly, for future research, this case study could be replicated at other grade levels with more focus on the teachers' perspectives.

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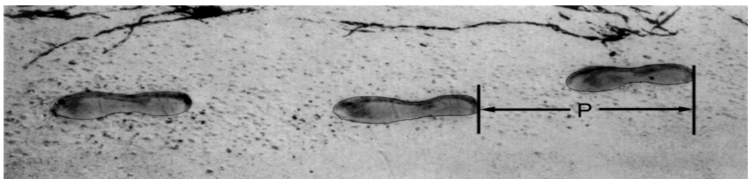
Appendix A

Part of the mathematical literacy enrichment specifying the overarching idea, lesson, Item Name, and the problems' proficiency level of a mathematical literacy PISA item.

Reference: PISA released items 2006 https://www.oecd.org/pisa/38709418.pdf (accessed on 5 February 2023).

Overarching Idea: Change and Relationships
LESSON 1: Functions and variations
PISA Item: Walking



The picture shows the footprints of a man walking. The pace length *P* is the distance between the rears of two consecutive footprints.

For men, the formula, $\frac{n}{P} = 140$, gives an approximate relationship between *n* and *P* where,

n = number of steps per minute, and

P = pace length in meters

Question 1 (Item ID: M124Q01, level 6)

If the formula applies to Heiko's walking and Heiko takes 70 steps per minute, what is Heiko's pace length? Show your work.

Question 2:(Item ID: M124Q03T, level 5)

Bernard knows his pace length is 0.80 m. The formula applies to Bernard's walking. Calculate Bernard's walking speed in meters per minute and in kilometers per hour. Show your work.

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