PREPARATORY YEAR: THE FILTER FOR MATHEMATICALLY INTENSIVE PROGRAMS

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ABSTRACT_ *Mathematical readiness for the tertiary level is an international challenge that has been addressed for many years and by many researchers. Students moving from secondary education to higher education lack mathematical competencies needed for college work. Some of the attempted solutions have been found useful. The Kingdom of Saudi Arabia addressed this challenge by introducing the Preparatory Year Program (PYP) as a post-secondary, pre-college program. The program intends to address students' mathematical skills, English language proficiency, and personality traits. This study aims to evaluate the effectiveness of the program to strengthen mathematical competencies needed for college level, especially from the point view of the students themselves. In that, the study investigates 1) if there are significant correlations between preparatory mathematics grades and college mathematics grades, 2) student's mathematics achievement at the PYP as a predictor of mathematics achievement at the college level, and 3) students' perception about the PYP program. The population of the study consists of students who completed the PYP and some of the courses in the academic program including the first college-level mathematics course. The sample was collected from one private university in Riyadh, the capital city of Saudi Arabia. The research results suggested that the grade earned in PYP mathematics courses correlates with the grade of the first college-level mathematics course. Furthermore, it was argued that the grades of math courses at PYP predict mathematics achievements when students move to the college-level. Students themselves agreed that the PYP strengthened students' competencies.*

KEYWORDS*: college readiness, mathematical competencies, mathematical readiness, preparatory year.*

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I. INTRODUCTION

It has been argued that being mathematically fluent or mathematically literate is a major factor influencing not only an individual's success Escalera-Cha'vez, Moreno-Garcl'a, Garcl'a-Santilla'n, & Rojas-Kramer [1], but also the nation as a whole Yore, Anderson, & Chiu [2]. In fact, higher education institutions use mathematical competencies as major admission criteria to determine students who are most likely to succeed if admitted to academic programs. Yet, as much as it is important to acquire mathematical skills, it is not straightforward and it requires a tremendous efforts and time. At the high school level, math is a cause of anxiety and stress Escalera-Cha'vez et al [1]. At the college level, students are usually not thrilled about studying mathematics courses. In some cases, studying mathematics courses is a nightmare that could cause students to change majors, switch colleges or even abandon higher education [3].

II. THE RESEARCH PROBLEM

"The Mathematics Problem" Faulkner, Hannigan, & Fitzmaurice [4] is a well-known educational challenge facing families, educators, and policy makers. It states that many students do not find it easy to comprehend mathematical concepts. Especially when considering mathematical readiness for college work, students are found to lack the essential needed skills. Research findings suggest that students are comfortable only with routine procedural problems and are insufficiently trained in analytical and logical thinking AlHarbi [5]; Bergsten, Engelbrecht, & Kågesten [6]. Such deficiency results in students struggle to complete higher education programs. Hence, tremendous number of studies have been conducted using data from England Hoyles, Newman, & Noss [7], Canada Kajander & Lovricj [8], Sweden Bergsten, Jablonka, & Ashjari [9], Germany Nagel & Kristina, [10] ; Ireland Liston & O'Donoghue [11], United states Giuliano & Sullivan, [12,13], Africa Julia & Veni [14] and the Middle East Salem & Swan [15]. The researchers addressed students' challenges, deficiencies and failures in mathematics courses at higher education institutions, and in many cases suggested approaches to ease the challenges.

This is not a newly tackled problem in the education field. For decades now, researchers have realized this problem, addressed it, and proposed several solutions! see Dalziel & Peat [16]; Kajander & Lovric [8]. Nevertheless, although the solutions might have helped in preparing students for higher education, the problem of students' readiness is still very much a concern for educators, researchers, parents, and students themselves. Many interventions have been attempted at the secondary level and at the tertiary level; yet, the gap seems to get even wider. Especially with the rapid increase in technology and the continuous change in the market demand, teachers are not able to transform pedagogy to cope with the required skills. The mathematics taught at the school level is not sufficient for the undergraduate level. Moreover, secondary and tertiary mathematics are disconnected from the mathematics we deal with everyday [17].

III. GOAL OF THE STUDY

The Kingdom of Saudi Arabia (KSA) faces the same challenge. The lack of essential skills in high school graduates and their deficiencies to meet the requirement in higher education academic programs have been pointed out many times in the media Alnatheer [18]. The government assigned 18% and 25% of its budget to education in 2010 and 2015, respectively Alsaeed [19]; AlSadaawi [20]; Murphy [21]. Saudi Arabia "has been increasing expenditure on education at a spectacular rate in recent years, and on higher education in particular" Pavan [22]. Nonetheless, still the outcomes are not satisfactory! Quantitatively is certainly not an issue; the number of schools, teachers, and administrations or the amount of financial resources are all impressively increasing [20]. However, the issue is the quality of the graduates. Especially looking at international standards, such as TIMMS' results (Trends in International Mathematics and Science Study), KSA graduates are far below the average Alnatheer [18]! Hence, there is an agreement among various stockholders that the quality of education needs to be improved [20].

One of the recent attempted solutions is the preparatory year program (PYP). To join higher education institutions, high school graduates must complete one full academic year of preparatory courses. PYP focuses on students' mathematical skills, English language proficiency, and personal development skills. The goal of this study is to evaluate KSA's attempted solution. The study examines the effectiveness of the PYP especially from the students' point of view.

Framework

This study aims to assess if the PYP has succeeded in preparing students for college-level mathematical courses. PYP focusses on several components with a major emphasis on English proficiency and mathematical competencies. With that being said, PYP varies among colleges; depending on the demand of the academic program, the structure of the PYP will be adjusted. For example, in some PYP programs, potential medical and engineering students should complete at least one level of calculus in the PYP, whereas, it is sufficient for business majors to complete advanced algebra courses. On the other hand, some PYP programs do not require mathematics at all if the intended program is in the college of humanities, for example. Hence, PYP acts like the filter for potential students. The framework presented in Crombie [42] is adjusted to match the goal of this study. Crombie emphasized that pre-calculus, college algebra or remedial math are all major components for successful transfer from secondary mathematics to college calculus. This framework is adjusted to match the need of the study with PYP being the component between secondary education and college-level mathematics. Figure 1 explains the framework of this study. As students complete secondary education and before moving to tertiary programs, they should pass through the filter: the Preparatory Year Program.

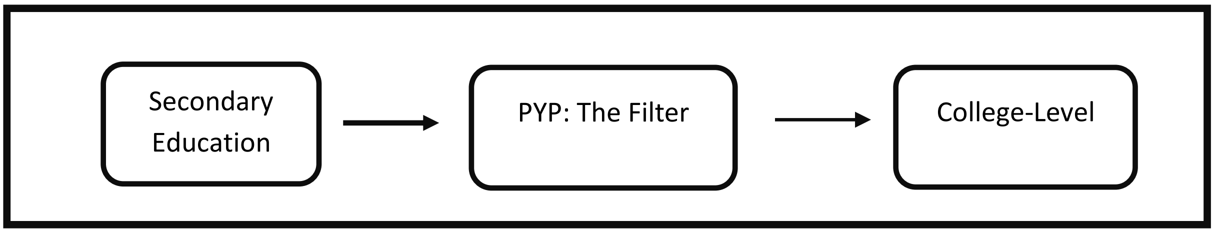

FIGURE 1
THE PATH FOR COLLEGE TRANSITION INCLUDES PASSING THROUGH THE FILTER: THE PREPARATORY YEAR PROGRAM

Need of the Study

Although the PYP has been implemented in all higher education institutions in the kingdom for few years now, minimal studies looked at its effectiveness. In fact, Ali [23] pointed out that the PYP has faced many criticisms from diverse stakeholders. Nevertheless, in other studies, it was also pointed out that PYP has been achieving its goals Alenaizy [24]; Alghamdi [25]; Alshumaimeri & Alghamdi [26]. It is important to mention here that only few of these studies looked at the effect of the program from the students' point of views. Moreover, all previous studies focused on public universities with minimal focus on private higher education institutions. Considering the amount of money, efforts, and time dedicated to the program, it is essential to measure the success of PYP by measuring its academic and motivational effect on students.

Literature Review

High school graduates face many problems when they move to higher education. They are just not ready or prepared for the need, demand, and environment of higher education. Particularly in mathematics classrooms, they are found to be deficient. Kajander and Lovricj [8] stated that students face difficulties in all subjects, but the problem is more serious with mathematics. This is apparent if we agree that mathematical aptitude is a core competency needed to succeed in undergraduate academic programs. In fact, it is used as an admission criterion in most higher education institutions around the world. If students are not equipped with the right skills in mathematics, they are vulnerable to fail in the rest of all courses. Researchers have looked into the reasons behind such phenomena and factors that could help ease the transitions. The literature addressing this issue is growing.

Reasons Behind the Struggle

When students move from secondary to tertiary education, they have to deal with many differences. First, the content of mathematics is more abstract. Second, the learning style is more students' dependent. Moreover, students are expected to search for the knowledge and be more active learners. With that, the personality, motivation, and attitude factors play a major role. Hoyles et al [7] discussed three key mathematical deficiencies found in first year college students:

The deficiency to think abstractly and solve proofs.
The inability to use algebraic basic skills and computation.
Low motivation and negative attitude.

Students' attainment of mathematics depends to a great extent on their attitude and disposition. Such attitude is built since elementary classes. In fact, the five strands for mathematical proficiency as presented by the National Research Council NRC [27] are as follows:

Conceptual understanding—comprehension of mathematical concepts, operations, and relation.
Procedural fluency—skill in carrying out procedures flexibly, accurately, efficiently, and appropriately.
Strategic competence—ability to formulate, represent, and solve mathematical problems.
Adaptive reasoning—capacity for logical thought, reflection, explanation, and justification.
Productive disposition—habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy.

These strands are not isolated from each other. The attitude or dispositions of mathematics vary across nations and among majors. For South America students for example, the anxiety and low self-confidence in one's ability are the major factors affecting performance Escalera-Cha'vez et al [1]. Furthermore, for Chinese students, motivation and positive attitude are factors of the curriculum reform Wang, Liu, Du, & Liu [28]. On the other hand, students majoring in non-science programs have a lower motivational level to mathematics than those majoring in a science field. Their backgrounds or previous knowledge might be different, which means that they come to higher education with a disadvantage of pre-knowledge of mathematics Varsavsky & Norton [29]. This affects their competence and self-confidence level, argued the authors.

One of the defined reasons behind the lack of mathematical readiness at the college level is the curricula at the secondary level. Mathematical concepts addressed in higher education are in many cases (and especially in primary levels) only expansions of what students have addressed in secondary grades. Still, the extent of abstraction increases dramatically in the tertiary education. Nagel and Kristina [10] argued that the most challenging part of the transition is the ability to use more intangible mathematics. It has been noted that there is no alignment between secondary school curricula and higher education. Wood [30] emphasized that there is a big difference in the contents itself, which affects the transition. The ability to generate proofs, argumentation, and analysis are not among the talent addressed in secondary school. So, there is discontinuity between school mathematics and university mathematics with regard to the content and expectation Nardi [31]. Kajander and Lovricj [8] concluded that one important reason behind the gap between secondary and tertiary education is that students are used to "a surface-learning attitude" and are not ready or prepared for the required "deep-learning activities" which require them to think, analyze, and reflect.

The personality factor is another important cause that has been argued by researchers Wood [30]. In that, some researchers emphasized that disposition or perception of mathematics is what hinder or support transition. Kajander and Lovricj [8] argued that students do not appreciate mathematics and do not see its value and benefits to their future and career. Hence, they fail to give it the amount of time and effort to comprehend the skills. Instead, if they see the value of mathematics, they will appreciate it and spend the needed time to adjust its theories. For example, Taiwanese students majoring in Science Earth experienced a modelling project that showed them the beauty of math Lim, Tso, & Lin [32]. The author claimed that the students' enjoyment of mathematics improved and they appreciated this approach of learning mathematics. Liston and O' Donoghue [11] claimed that pre-perception is very important. Beliefs and attitudes toward mathematics—which was built on the high school experience—has a major role in helping students survive with the new environment. Moreover, Bergsten et al [9] agreed that perception on what students will get out of the mathematics class is important. In the Middle East, an instructor at Zayd University in United Arab Emirates explained that students' maturity and willingness to work in addition to their general skills influence their success in the subjects Salem & Swan [15]. Bergsten et al [9] also argued that the change in the environment, pedagogy and expectation play a major role. The authors indicated that one important factor that affects transition is students' acceptance that they need to be independent of their teacher and dependent on themselves to gather the knowledge. As stated by Wood [30], the change in the teaching style and the approaches of delivering the knowledge is one major factor that affects transition. On the other hand, students will be dealing with a more diverse group of students and teachers than what they are used to in school Julia & Veni [14]. Besides, in many parts of the world (including KSA), students in secondary grades do not need to deal with scheduling, class location or textbooks. Everything is planned and provided to them. But when they move to colleges, this service is not available anymore.

On the contrary, in some recent studies, the challenge of transition is viewed as "an opportunity" rather than a problem Hernandez-Martinez, Williams, Black, Davis, Pampaka, & Wake [33] The authors stated that educators need to re-think and "re-read" the issue of transition claiming that students probably do not agree with them on their view of the issue. In that, they argued, "transition can be viewed as growth of identity, largely due to the challenges and demands that the new institution poses, where the chance to become a new person can be exploited by many learners.

Attempted Solutions

Over many years, educators and researchers attempted to solve and address the challenge of the transition. Several solutions have been and are still used up to date:

Solutions at the high school level.

Addressing high school curriculum Nagel & Kristina [10] to make it more engaging and connected to students' lives and needs could encourage students to spend the required time and effort needed to succeed, especially in mathematics classrooms. In that, curriculum writers are for years now trying to address world problems and present the concepts in ways that connect to students' minds and address their needs.

In many cases, the solution is viewed to be in the hand of students themselves. Students' personalities and ability to adjust to the new environment and response to the new demands will make the transition easy [16].

Moreover, it is important to address teachers' pedagogical skills and subject-matter knowledge Blackboard institute [34]. Teachers should be aware of basic leaning theories, especially with regard to how students learn and construct knowledge. Teachers are encouraged to support independent study habits and teach students how to search for the knowledge instead of just giving it to them.

Solution beyond secondary education. Some programs—beyond the high school level—are performed around the world with an aim to prepare students for college.

The Black Board institute in the United States is one example of such programs. Summer courses are in place to bridge the gap between secondary education and tertiary education Giuliano & Sullivan [12,13]. "Summer Success... was very influential and beneficial. Without the support and guidance that I received during and even after the program I would have had a very tough time with college and dealing with all the transitions college entails [12].

Another approach used internationally is by addressing first year university courses, or using bridging courses as used by Wood [30]. These are also called foundation courses, remedial courses, or pre-calculus courses. Kajander and Lovricj [8] strongly recommended bridging courses that equip students with the needed skills before their actual first course in university mathematics. The university itself provides such courses to students to strengthen their skills (if it was noted they need such programs). The idea of bridging courses to address limitations in students' skills and help them cope with what to come is actually not new and it goes back even to World War II. Wood [30] stated that soldiers coming back after the war and in order to help them catch up what is left of their studies, the idea of such courses was introduced.

In the United States of America, community colleges offer a two-year degree. However, they are also considered one way to help prepare students to join a four-year program and graduate with a bachelor degree. High school graduates who did not achieve acceptable grades that allow them to be admitted to a university could join an open-door, open-admission community college. After graduating, the student could use the earned credit to continue the bachelor degree in universities [35].

In other cases, students will be admitted into the academic program but will be provided with additional support. Examples include mathematical tutorial sessions (either individual or group sessions), workshops, additional resources or materials, review sheets, and practice problems Wood [30]. Additionally, the Professional Orientation program is an indirect support for students during their first year Steyn & Plessis[36]. The program aims to improve "students' mathematical skills (understanding of the fundamental concepts underpinning calculus); technical and mathematical communication as in reading, the formulation of concepts and writing of mathematics as well as personal skills (such as time management, study skills, co-operative learning". The researchers argued that such program improved students' mathematical competencies during their first year at college.

The context of KSA. The Kingdom of Saudi Arabia tried several approaches to address the transition problem at the school level and beyond the school level. One solution is to change the selection process. So, the National Center for Assessment (Qiyas) has been established in 2001. Qiyas is a nation-wide independent assessment center that aims to assess students' abilities and academic skills in the fields of English Language, Mathematics, and Science, in addition to students' critical and analytical skills. Qiyas guides the process of assessment with an overall goal to improve the selection and admission process to higher education institutions Alnatheer [18]. Since the establishment of Qiyas, admission to higher education institutions does not depend on high school Grade Point Average only, but also depends on the score of the two national large-scale assessments offered by Qiyas to high school graduates, the General Aptitude Test (GAT) and the Standard Achievement Admission Test (SAAT). It is also important to mention here that GAT and SAAT were supported by many recent studies as predictors of students' success AlQataee & AlHarbi [37]. However, high school Grade Point Average (HSGPA) was shown as even a stronger predictor [38].

Another approach used by KSA is the preparatory year program (PYP). PYP is one full academic year beyond high school. It consists of a set of courses that must be completed before joining academic program. The set differs among universities but all PYP include courses that focus on mathematics, English language, and personality and communication skills. In other words, Saudi educators and policy makers agree that mathematical skills, English proficiency and higher education personality characteristics are all lacking among high school graduates and hence, must be addressed in the PYP. PYP has full support from the universities. In fact, in many cases, a separate deanship is created to support the PYP [39].

The rule played by PYP is similar to the bridging courses in the US or Australia or summer program as mentioned in Giuliano & Sullivan [13]. The goal of the bridging courses or summer programs is to prepare students to the tertiary level of mathematics Gordon & Nicholas [40]. The difference though, is that the bridging courses or summer programs are given to those who proven to need it (showed that they are not ready for tertiary mathematics); however, PYP is mandatory for all students in most universities in the KSA. With that being said, for some limited academic programs, completing PYP is not an essential requirement. On the other hand, in some private universities, students could provide evidence of their mathematical competencies—and so waive PYP mathematics courses—or English proficiency—and so waive English PYP courses. In that regard, the structure of PYP varies depending on the intended college or program. For example, PYP for students majoring in one of the College of Business Administration programs, the Education College, or Humanities College does not include calculus. Calculus is required for students majoring in engineering and science only.

IV. METHODOLOGY

Population, Sampling, and Data Collection

The purpose of this study is to look at the effectiveness of PYP mathematics courses on mathematical readiness at the college level. The population of the study consists of students who completed the PYP and some of the courses in the academic program including the first college-level mathematics course. The sample is collected from one private university in Riyadh, the capital city of Saudi Arabia, where students completed two mathematics courses at the PYP level and at least one mathematics course at the college-level. This study uses both qualitative and quantitative approaches.

First, for the quantitative stage, students academic years 2010−2014 who completed the first college-level mathematics course after completing the two mathematics courses at the PYP are considered for the study. Data set includes 1160 subjects from the College of Computer Sciences and Information Systems, the College of Engineering, and the College of Business Administration. The data was collected through the Deanship of Admission and Registration. The average grade of the two mathematics courses at the PYP (PMG) of the 1160 subjects is used as an independent variable and the grade of the first mathematics course at the college level of the 1160 subjects is used as a dependent variable (CMG). The first college-level mathematics course varies depending on the college. For this research, we consider the first college-level mathematics course at three colleges:

College of Business Administration (CBA)—Finite Mathematics.

College of Computer Sciences and Information Systems (CCIS)—Calculus I.

College of Engineering (CoE)—Descriptive Geometry.

The data was collected in Excel spreadsheet in order to do analysis using XLSTAT. The four-year data of all eight semesters was downloaded and scrutinized through intensive screening. The sample was limited to students who took both semesters of the PYP before starting their major. In other words, students who secured transfer directly to college programs were excluded from the sample. The analysis was done in two separate stages: First, by combining the grades of all three college-level courses. In this case the dependent variable is CMG. Second, by categorizing the dependent variable per college. In this case the dependent variable will be CMGBUS, CMGCCIS, CMGCoE, respectively. The descriptive statistics of the sample were generated for the quantitative characteristics: PMG and CMG. It is important to mention here that the grading system is a standard international system where an earned grade could vary from F (= 0 points) to A+ (= 4 points).

Moreover, qualitative data were collected through 30-minute individual interviews, and 45-minute focus-group interviews. The samples for the interviews were sophomore students during 2016–2017 or 2017–2018. Sophomores are preferred as participants for the interview for the reason that they have the minimum required experience at the college level—which is one year —yet, their experience with PYP is still fresh in their minds. Twenty-four students from various academic programs and standards were invited by emails to participate either in individual interviews or focus-group interviews based on their preferences. The twenty-four students were chosen based on potential willingness and convenience. The invitation email explained the purpose of the study and provided privacy and anonymity data collection assurance. Those who agreed to participate signed the consent form (Appendix A).

A total of 10 students participated from all three colleges: three for individual interviews and seven for focus- group interviews. The first two authors conducted the interviews during the period from 24 April 2018 through 9 May 2018. The meeting took place in a faculty member office at the university. Only those who completed PYP and the first college-level mathematics course were considered.

The interview protocol was semi-structured. The researchers developed seven specific, open-ended questions for the interview protocol. However, the researchers used follow up questions when appropriate (Appendix B). The questions focused on the perception, opinion, and experience of the participants during PYP and college level with regard to mathematics courses. The participants were asked to reflect on negative or positive experiences. It is important to mention here that data was collected only upon the Institutional Review Board (IRB) approval.

Upon completing the interviews, the data was transcribed by the same researcher who conducted the interview. The data was letter-coded for individual interviews and letter-number-coded for the focus-group interviews to ensure privacy. So, we had Participant A, Participant B and Participant C for individual interviews and then Participant D1, Participant D2… for focus-group interviews. Then, the researchers read through the transcribed data, organized it and categorized it. The researchers then identified themes and perspectives that helped them in writing their interpretations of the data. The main goal of the interview data is to support the results of the quantitative section.

Research Questions and Hypothesis

The following null hypothesis is proposed: PYP mathematics courses do not affect students' mathematics competencies at the college-level. The null hypothesis is tested through quantitative tests. The research questions are as follows:

Is there any significant correlation between the grade of mathematics courses at the PYP (PMG) and the grade of the first mathematics course at the college level (CMG)?

Does PMG predict CMG?

What are students' perception about the importance and effect of the PYP on them?

V. RESULTS

The purpose of the study was to measure the effect of PYP mathematics achievements on college-level mathematical skills. The first and second questions were tested using the quantitative data.

Quantitative Analysis

The sample data of 1160 students showed that the Mean of CMG is 2.527 (SD = 1.074) and the Mean of PMG is 2.727 (SD = .908). The first secondary question was addressed through the correlation coefficient, which indicated that there was fairly strong positive correlation between PMG and CMG ($r = 0.598$), which means that CMG and PMG tend to increase or decrease together. The Coefficient of Determination (.357) explains nearly 36% variation in CMG. The Durbin –Watson goodness of fit statistics = 1.467 (less than 2) shows that residuals are not auto-correlated (Table 1).

TABLE 1
Goodness of Fit Statistics (CMG)

Observations	**1160**
Sum of weights	1160
DF	1158
R^2	0.357
Adjusted R^2	0.357
MSE	0.742
RMSE	0.862
DW	1.467

The next secondary question was addressed by an ANOVA test. The ANOVA results showed that PMG predicted very well the CMG ($p = < .0001$). Thus, at 0.05 it was concluded that PYP mathematics achievement is a predictor of college-level mathematics achievements. Overall, the model is significant. The t-test resulted in a significance effect of PMG (Table 2) at alpha = 0.05. Thus, at the 95% confidence level, based on the sample data, it is concluded that a 1-unit increase in PMG will result in increase in CMG. The estimated regression (Equation 1) indicated that for a 1-unit increase in PMG one can expect an average increase of 0.71 increase in CMG.

Table 2
Regression Output of the Model (PMG)

Source	**Value**	**Standard error**	**t**	**Pr> |t|**	**Lower bound (95%)**	**Upper bound (95%)**
Intercept	0.602	0.080	7.520	< 0.0001	0.445	0.759
PMG	0.707	0.028	25.367	< 0.0001	0.652	0.761

$$CMG = 0.6018+0.7067*PMG \quad (1)$$

Next, the study now considers each college performance in its first college-level math course to find out which college-level math course can be best predicted by PMG.

College of Business Administration's first college-level mathematics course is finite mathematics. The following analysis shows that using the sample data of 530 CBA students, the Mean CMGBUS is 2.54 (SD = 1.055) and the Mean of PMG is 2.327 (SD = .862). It was noted that there was fairly strong positive correlation between PMG and CMGBUS ($r = 0.662$), which means that PMG and CMGBUS tend to increase or decrease together. The Coefficient of Determination (.438) explains nearly 44% variation in CMGBUS. The Durbin –Watson goodness of fit statistics = 1.672 (less than 2) shows that residuals are not auto-correlated (Table 3).

TABLE 3
Goodness of Fit Statistics for CMGBUS

Observations	**530**
Sum of weights	530
DF	528
R^2	0.438
Adjusted R^2	0.437
DW	1.672

To examine if PMG is a predictor of CMGBUS, we used the ANOVA test. The results showed that PMG predicted very well CMGBUS (p = < .0001). The t-test resulted in the significance effect of PMG (Table 4) at alpha = 0.05. Thus, at the 95% confidence level, based on the sample data, it is concluded that a 1-unit increase in PMG will result in increase by an average of 0.8107 in CMGBUS (Equation 2).

TABLE 4
Regression Output of the Model (CMGBUS)

Intercept	**0.654**	**0.099**	**6.594**	**< 0.0001**	**0.459**	**0.848**
PMG	0.811	0.040	20.288	< 0.0001	0.732	0.889

CMGBUS = 0.6537 + 0.8107*PMG (2)

Moreover, the College of Computer Science and Information Systems (CCIS) required Calculus I during the freshman level. The sample data of 215 CCIS students was used. The Mean of CMGCCIS is 2.641 (SD = 1.069) and PMG is 3.179 (SD = .772). It was noted that there was fairly strong positive correlation between PMG and CMGCCIS (r = 0.764). The Coefficient of Determination (.582) explains nearly 58% variation in CMGCCIS. The Durbin –Watson goodness of fit statistics = 1.743 (less than 2) shows that residuals are not auto-correlated as shown in (Table 5).

TABLE 5
Goodness of Fit Statistics CMGCCIS

Observations	**215**
Sum of weights	215
DF	213
R^2	0.584
Adjusted R^2	0.582
MSE	0.478
RMSE	0.691
DW	1.743

To examine the effect of PMG, the ANOVA test was used. The results showed that PMG predicted very well the CMGCCIS (p = < .0001). The t-test resulted at alpha = 0.05 showed significant effect of PMG (Table 6). Thus, at the 95% confidence level, based on the sample data, it is concluded that a 1-unit increase in PMG will result in increase in CMGCCIS by 1.058 in CCIS College Math GPA as shown in (Equation 3).

TABLE 6
Regression Output of the Model (CMGCCIS)

Source	**Value**	**Standard error**	**T**	**Pr> |t|**	**Lower bound (95%)**	**Upper bound (95%)**
Intercept	-0.724	0.200	-3.615	0.000	-1.119	-0.329
PMG	1.058	0.061	17.286	< 0.0001	0.938	1.179

CMGCCIS = -0.7239+1.0583*PMG (3)

Finally, students of the College of Engineering (CoE) are considered. Their first college-level math course is Descriptive Geometry. The sample data of 415 CoE students was used. The Mean of CMGCoE is 2.452 (SD = 1.097) and PMG is 2.998 (SD = .818). There is quite a fair strong positive correlation between PMG and CMGCoE (r = 0.6), which means that PMG and CMGCoE tend to increase or decrease together. The Coefficient of Determination (.359) explains nearly 36% variation in CMGCoE is explained by the model. The Durbin –Watson goodness of fit statistics = 1.630 (less than 2) shows that residuals are not auto-correlated (Table 7).

TABLE 7
Goodness of Fit Statistics CMGCoE

Observations	**415**
Sum of weights	415
DF	413
R^2	0.359
Adjusted R^2	0.358
MSE	0.773
RMSE	0.879
DW	1.630

To examine if PMG is a predictor of CMGCoE, we used the ANOVA test. The results showed that PMG predicted very well CMGCoE (p = < .0001). The t-test resulted in the significance effect of PMG (Table 8) at alpha = 0.05. Thus, at the 95% confidence level, based on the sample data, it is concluded that a 1-unit increase in PMG will result in increase by an average of 0.8039 in CMGCoE (Equation 4).

TABLE 8
Regression Output of the Model (CMGCoE)

Source	Value	Standard error	t	Pr> |t|	Lower bound (95%)	Upper bound (95%)
Intercept	0.042	0.164	0.257	0.797	-0.280	0.365
PMG	0.804	0.053	15.223	< 0.0001	0.700	0.908

$$CMGCoE = 4.2179E\text{-}02+0.8039*PMG \quad (4)$$

Qualitative Analysis

The third research question was addressed through individuals and focus-group interviews. When students were asked about the value of the PYP in general and PYP math courses in specific, there was an agreement among all 10 participants that the program supported them and improved their skills. Participant B indicated that "PYP was interesting, it was a whole new environment. I learned a lot about English and communication skills…" Moreover, Participant D1 when asked about the PYP reacted "now I know how to manage my time…". Nevertheless, some students indicated that two semesters of PYP is a long period and they suggested to merge some courses of communication skills and physical health. Interestingly, none of the students suggested merging the two mathematics courses even when they were asked directly about them. All of them saw the value of PYP mathematics courses.

All students agreed that the contents of mathematics courses at the PYP were not difficult and that they considered them the refresher courses. However, they all agreed that those with high English language proficiency did not face a problem with math courses, but those who had an issue with the English language had to put additional efforts on PYP mathematics courses. On the other hand, it was indicated that the first mathematics course was more demanding than the second course. Participant A who suggested this said "because Math001 was after high school immediately, it was more difficult than Math002 because of the language issue and because we were new to the environment…"

With regard to the effect of PYP mathematics courses on their college-level experiences, all students agreed that PYP math courses were very helpful. However, they also had other comments. CBA students, for example, suggested to have more business-oriented mathematics tasks during the PYP level to prepare them for their program. However, CCIS students said that their mathematical skills have improved, but they do not see a direct connection between PYP mathematics and calculus (college-level course for the CCIS). Moreover, some engineering students, although agreed that PYP was helpful, thought that their first college-level geometry course was challenging.

When they were asked to give final comments, suggestions, or advice to other students, Participant C said, "It is hard, but you will learn a lot. You will be better and your English will be improved". Likewise, most participants agreed that PYP must be related to the major. Meaning, they opposed to the fact that PYP is unified for all majors and strongly suggested that PYP math courses should be directly related and address the need for each specific college.

Summary of the Analysis

The results presented in this section divulge some noteworthy results. Achievements of college-level mathematics courses correlate positively with the achievements of PYP mathematics course. Moreover, when considering the setting for each college separately, the correlation remains positive and strong with slight variation among colleges. Since the data was collected over a period of eight semesters, there was a chance of autocorrelation between the residuals, The Durbin-Watson test statistic showed that no such auto-correlation existed between them. Correspondingly, the suggested simple linear regression model is a best-fit model for all three colleges and overall as combined colleges. These resulted were supported by the qualitative data; the interview data indicated that students themselves agreed that PYP math courses supported them when they studied college-level mathematics courses. Hence, we conclude that the null hypothesis "PYP mathematics courses do not affect students' mathematics competencies at the college-level" could be rejected.

Discussion and Implications

For many years, researchers have tried to explain students' mathematics struggle—and in many cases failure—when they move to higher education. Over time, many attempted solutions have been tested. Although, some approaches have been proven successful in minimizing the gap between secondary education and higher education, the challenge maintained to be an issue for educators, researchers, parents and students themselves. At the Kingdom of Saudi Arabia, the PYP was introduced as a post-secondary, pre-college program that aims to strengthen students' competencies and prepare them for college and one of the major goals of PYP to address mathematical readiness. PYP has been shown to be a valuable asset; yet, time, efforts, and money are all factors to be considered. Do PYP mathematics courses prepare students for college-level mathematics? Is there any significant correlation/prediction relation between the grade of mathematics courses at the PYP and the grade of the first mathematics course at the college level? What are students' perception about the importance and effect of the PYP? This research attempted to answer these questions using a sample from one private university in Riyadh.

The statistical analysis supported that the grade earned in PYP mathematics courses correlates with the grade of the first college-level mathematics course. Furthermore, it was suggested that the grade of math courses at PYP predicts mathematics achievements when a student move to the college-level. Moreover, the qualitative data reflected a clear agreement among students that PYP is valuable to students' college attainment. Specifically considering mathematics PYP courses, the interview participants only confirmed that mathematics contents covered in PYP supported students at the college level.

Such results are also coinciding with the current literature that evaluated PYP. Alenaizy [24] and Alghamdi [26] argued that various stakeholders believe that PYP supported students' readiness. Moreover, the Center of Excellence in Learning and Teaching at King Saud University examined the effect of PYP. One of the suggested results that students' achievements at the end of the first semester is significantly better for those who have completed the PYP before joining the college (Center of

Excellence in Learning and Teaching [41].

With all that being said, and with the fact that the PYP has started more than a decade ago, we should expect a clear improvement with regard to high school graduates' competencies. Hence, many investigations still needed to be done! Maybe the PYP is effective; yet, it is not enough to show a remarkable change. Maybe addressing the gap after the high school is just too late and some interventions should take place earlier. It is important here to mention that some universities have decided to cancel the PYP starting 2017 academic year. They instead imbedded the program among the intended academic program. In that, we believe that their goal is to make PYP related to the major, which is one recommendation from the interview participants. Whether this approach will work or not is yet to be seen, but for now, other investigations are needed to support those who are still implementing the PYP.

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