



## THE EFFECT OF USING MATHWAY ON DEVELOPING SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN MATHEMATICS IN NAJRAN, KINGDOM OF SAUDI ARABIA

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### Abstract:

This study aimed to identify the effect of using the Mathway application on the development of academic achievement in mathematics among secondary school students in Najran city. The study population consisted of all students in the second year of secondary school who study Mathematics -4- in the second semester of the academic year 1442 AH in Najran city. The study followed the quasi-experimental design, which was conducted on a sample of (83) students divided into (41) students in the experimental group studying using Mathway application, and (42) students in the control group who studied using the traditional method. To ensure that the two groups are equal, a pre-achievement test was prepared before the experiment, and a post-achievement test was prepared to find out the differences between the two groups after applying the experiment. The results of the study showed a statistically significant difference at ( $\alpha \leq 0.05$ ) between the means of the experimental group and those of the control group in the post-academic achievement test in favor of the experimental group due to the use of Mathway application. In light of the results, the study recommended using Mathway application and similar applications in the processes of teaching and learning mathematics.

**Keywords:** Mahtway application, mathematics, academic achievement

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## 1. Introduction

Academic achievement is one of the elements of great interest to educators and enjoys a high status among them. It always preoccupies them who are constantly looking for how to develop it. It is one of the important criteria for judging the level of students and the extent of their progress to move from one stage of study to another. Several previous studies indicated low levels of academic achievement for students in general and in mathematics in particular. In addition, the researchers in the educational field see weak academic achievement, weak motivation among students towards learning mathematics. Also, some mathematics teachers still insist on teaching mathematics in traditional methods and do not employ modern technologies that make the student an effective participant and contribute effectively to solving problems education faces and reducing individual differences among students.

One way to solve these problems is to integrate smart devices technology into the teaching and learning processes such as Mathway. It offers a wide range of topics with over 400 different topics including pre-algebra, algebra, trigonometry, calculus, and linear algebra, all arranged clearly and easily. Each of these areas contains topics that are from the student's specialization, which makes it easier for him to reach the solution faster. Mathway helps students solve endless problems. In 2019, Mathway solved more than 1.3 billion problems for students (Ford & Boxser, 2020).

In general, Mathway makes the processes of learning and teaching mathematics very easy as it supports these processes. It is programmed as per the international standards of mathematics and supports the approved mathematics curricula. Therefore, it is not a substitute for them. It offers algebraic and engineering capabilities that enable the student to find solutions on his own and teach him mathematical skills. It also can deal with different mathematical applications in a way that attracts the student. In addition, it provides him with the tools he needs to solve the problems he faces in mathematics (Al Blushi, 2018).

The use of smart devices and the applications they contain in teaching and learning mathematics such as Mathway, Geogebra, Photomath, Todomath, Microsoft Math and others helps develop the student's academic achievement and enhances their understanding. Also, it saves their effort and time and helps reduce the gap between students by reducing individual differences. Students who used smart device applications performed better than those students who did not use them. Therefore, the introduction of smart devices in learning and teaching may help students raise their academic achievement levels, which in turn leads to the quality of provided education (Al-Bado, 2017; Al-Blushi, 2018; Alkhateeb, 2019; Alkhateeb & Al-Duwairi, 2019; Al-Omeishat, 2019; Etcuban & Pantinople, 2018; Fabian et al., 2018; Hadjinor et al., 2021; Mhlanga, 2018).

The use of smart devices and the features they contain in teaching students of different ages to impact them positively more than if they were taught using traditional methods. This is because smart devices provide interactive educational applications that

attract and entice students to learn and are suitable for their different abilities. Also, the ease of interaction with this information makes students attracted to and accept the educational process. This helps to improve students' performance and raise their academic achievement levels, which leads to the effectiveness of the teaching and learning processes (Altaf, 2019; Alyan & Al-Qasimiyah, 2019; Al-Zahrani, 2019; Demir & Akpinar, 2018; Elfeky & Masadeh, 2016; Kattayat et al., 2017; Klimova, 2019; Quispe, et al., 2018; Saadoun, 2018).

What has previously been presented is evidence of the importance of integrating technology in general into the educational process, especially mobile and smart devices and the applications they contain. Their advantages support the educational process and make it continuous, and address its weaknesses, especially if these technological innovations are integrated into the processes of teaching and learning mathematics. This integration includes positive aspects that enhance the tendency towards mathematics and contribute effectively to helping students understand and solve mathematical problems and identify their steps. Thus, they lead to raising the levels of students' academic achievement and progress in the educational process.

Moreover, the premises of the previously mentioned studies indicate a low level of students' academic achievement. Also, the traditional methods of teaching, which do not help in overcoming the difficulties of learning mathematics are still used in teaching today. The problem of the study is summarized by answering the following main research question:

- What is the effect of using the Mathway application on the development of academic achievement in mathematics among secondary school students in Najran city?

### **1.1 Hypotheses of the study**

Upon the review of the results of previous studies, the hypotheses of the study were formulated as follows:

- There is a statistically significant difference at ( $\alpha \leq 0.05$ ) between the means of the experimental group and those of the control group in the post-achievement test.

### **1.2 Objectives of the study**

This study attempts to:

- examine the effect of using Mathway on developing secondary school students' academic achievement in mathematics in Najran city.
- show any significant differences between the students' means in the experimental and control groups in the post-academic achievement test.

### **1.3 Significance of the study**

The significance of the current study lies in the following:

- 1) The results of this study may encourage teachers to use and integrate some smart device applications in teaching and learning mathematics.

- 2) This study may be useful in directing researchers to study the effect of using Mathway on other variables such as attitudes towards mathematics, mathematical proficiency, etc.
- 3) The current study may contribute to directing mathematics teachers to use Mathway in solving mathematical problems and encourage students to use the application to ensure the correctness of their solutions.

#### **1.4 Delimitations of the study**

The study was delimited to the following:

##### **1.4.1 Place**

The study was implemented at King Abdulaziz Secondary School in Najran, Saudi Arabia.

##### **1.4.2 Time**

The study was implemented in the second semester of the academic year 1442 AH.

##### **1.4.3 Topic**

This study was delimited to the application of Mathway as the independent variable and academic achievement in the unit (relations and functions) of Mathematics -4- as the dependent variable.

##### **1.4.4 Human being**

A sample of the second year of secondary school students who study Mathematics -4- in government day schools in Najran city.

#### **1.5 Key terms of the study**

##### **1.5.1 Smart devices**

They are defined as mobile phones and tablets, whose role has gone beyond sending and receiving calls and short messages as in old mobile phones. They are devices that run operating systems such as Android and iOS systems or other systems, through which it is possible to browse the Internet, follow e-mail, play multimedia, and download many applications through the store for each system (Al-Ajrami, 2019). Procedurally, they are all portable smart devices regardless of their different sizes, manufacturers, and operating systems, which can connect to the Internet and many features. Also, they are to download and install the Mathway application.

##### **1.5.2 Mathway application**

Mathway is an application through which mathematical problems are solved in various fields. The problem is entered manually or a picture of the problem is taken. Then, it is solved immediately (Al-Bado, 2017). It is procedurally defined as an application that is downloaded on smart devices, and through algebra, it helps explain and teach the topics

of the unit of relations and functions from Mathematics -4- for students of the second year of secondary school in Najran city.

### **1.5.3 Academic achievement**

It is the set of knowledge and skills acquired and developed during the study subjects, usually indicated by test scores or those scores assigned by teachers, or both (Shehata & Al-Najjar, 2003). Procedurally, it is the grades obtained by the second year of secondary school students in the achievement test prepared by the researcher on knowledge and skills in the unit (Relations and Functions) of Mathematics -4-.

## **2. Review of literature**

### **2.1 Mathway application**

Mathway was established in 2002, and it was a collection of CDs containing information on specific topics in mathematics. In 2008, the website [www.mathway.com](http://www.mathway.com) was launched. Problems are solved in various branches through this site using different Internet browsers. In 2012, the Mathway application was launched, which is used through smart devices. It relies on the Internet to solve various mathematical problems (Firmage, 2020).

The Mathway application is considered the best solution to math problems that a student may face in his career, whether in his general or university education. It deals with many branches of mathematics such as algebra, trigonometry, calculus, linear algebra, statistics, graphs, etc. When a student wants to solve a specific problem in mathematics using Mathway, he just needs to write the problem or take a picture of the problem to get the answer instantly and free. If the student wants to get step-by-step solutions, a subscription is available at a certain price, so Mathway provides instant help to students anywhere and anytime (Mathway, 2012).

It is noted the application logo is taken from the application website. Mathway is translated into the math method. Also, the icon shows that it combines the first letter (M) of Math and the first letter (W) of way, which produces the symbol of infinity in mathematics. Perhaps, it is a metaphor for the application's ability to solve an infinite number of questions and mathematical problems.

The Mathway application like those of smart device applications in mathematics on different operating systems is characterized by several features that support and enhance the educational process. These features stem from the advantages of learning using smart devices as well as the most important points of Thiagarajan (2020)'s points at:

- Smart devices applications in mathematics are convenient in handling, easy to use, and low in cost; they are in the hands of students at any time and any place. They also provide feedback to students quickly.
- These applications increase the effectiveness of students and attract them to the learning process, given the way mathematical problems are presented through



smart device applications. They are digital platforms that make the student not see them as homework, but rather as electronic games or entertainment applications. This leads to drawing his attention towards learning.

In addition to the above, the use of mathematics applications in general, and Mathway in particular, helps the student to depend on himself and teaches him self-learning methods. It helps him not to rely on others and assists in overcoming the difficulty of mathematics by integrating this type of technology into the educational process. Also, it increases the student's self-confidence and removes his fear of mathematics; being aware that he can solve any mathematical problem he encounters, and the application helps him identify his weaknesses.

## 2.2 Examples of solving questions using the Mathway application

### A. Determining the values at which the function is undefined by applying the Mathway

Example: Determine the value of  $x$  that makes  $f(x) = \frac{3}{2x+5}$  undefined.

After selecting the (Algebra) branch from the drop-down list , the student writes the equation through the application or opens the camera and then directs the camera to the equation to capture it. Then, he presses on the symbol  and chooses (find where undefined/discontinuous) to show the solution. After that, he presses Review the steps to enter the steps of the solution so that the solution is shown as in Figure 1.

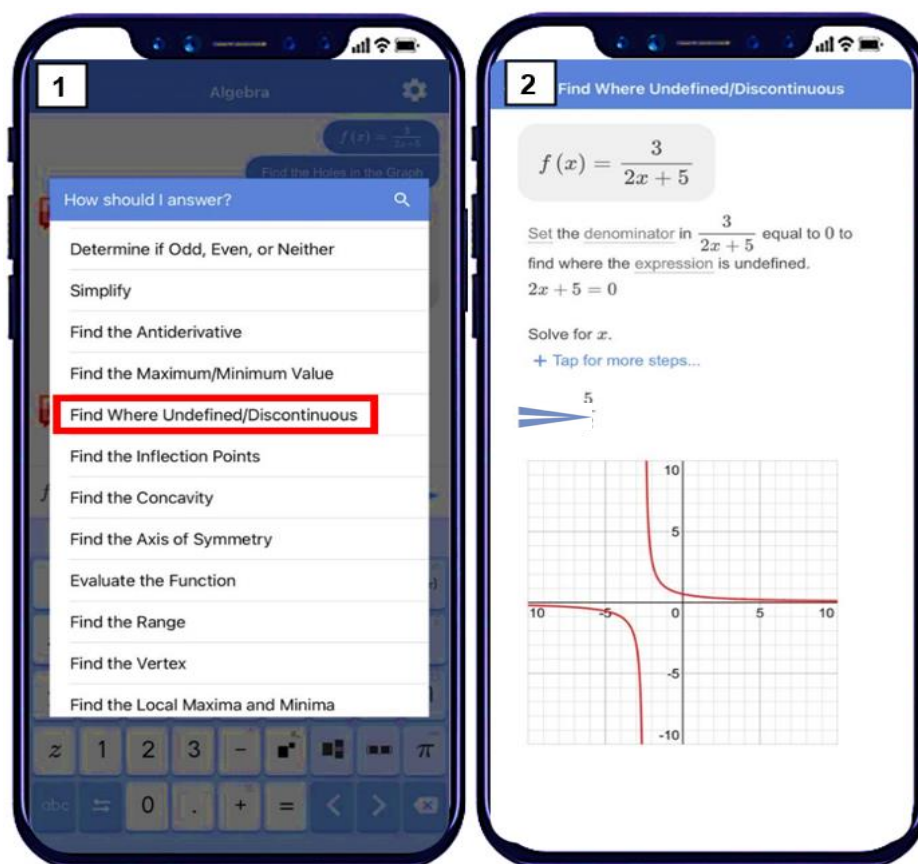


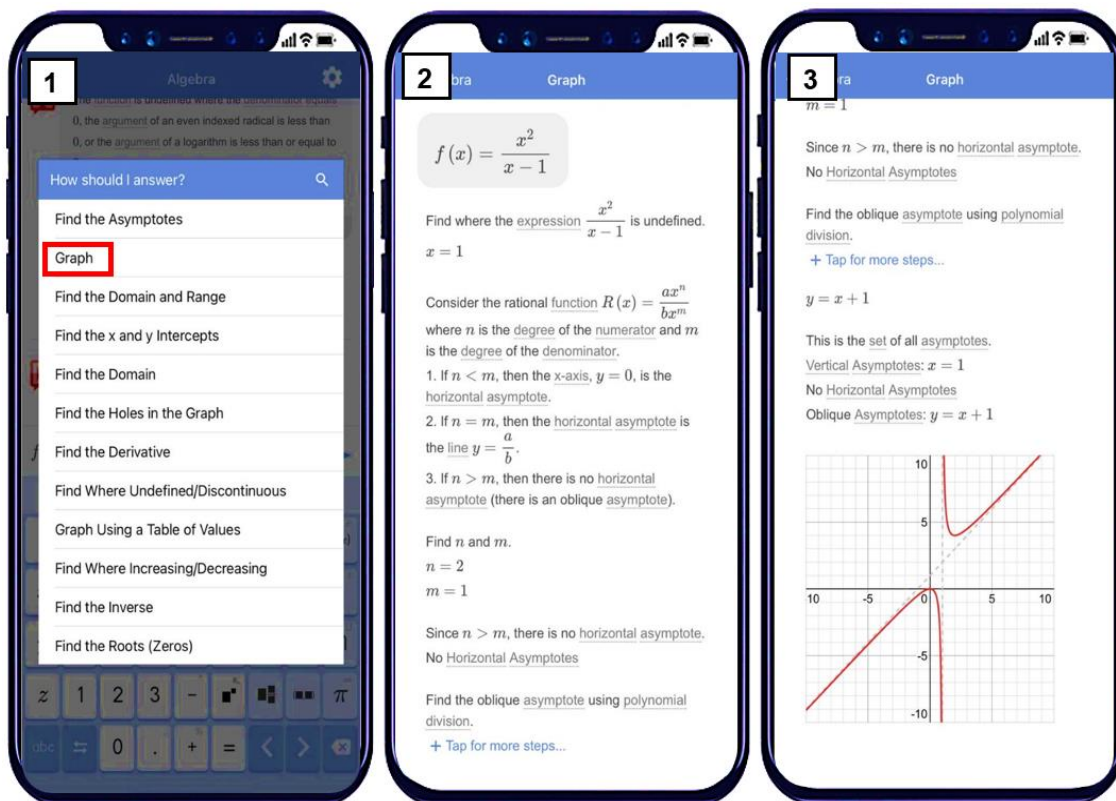


Figure 1: Finding the values that make the function undefined using Mathway

## B. Representation of a given rational function using Mathway

Example: Graph the function  $f(x) = \frac{x^2}{x-1}$ .

After selecting the (Algebra) branch from the drop-down list , the student writes the equation through the application or opens the camera and then directs the camera to the equation to capture it. Then, he presses on the symbol  and chooses (Graph) from the list to show the solution. After that, he presses on Review the steps to enter the solution steps as shown in Figure 2.



**Figure 2:** Representation of a given rational function using Mathway

Figure 1 and Figure 1 show the written commentary in each step of the examples, and this explains to the student how to reach this step of the solution. Also, this clarification enables him to link each step with the next step logically and orderly. The student must realize the logical justification for each step in the solution when using Mathway and not only obtain the solution without explaining how to reach the final solution. When the student solves the questions with his hand based on examples he has already solved and realizes its steps through the application of Mathway, this helps him to check his solution and know whether he is right. Moreover, this makes him self-confident and self-esteemed when he solves the exercises correctly. He becomes unafraid of mathematics and makes mistakes as well. Likewise, he does not need another person who may be ashamed of him when he learns that he has made a mistake. Thus, the students must include in Mathway and aware of the steps of each issue, and the role of the teacher is to supervise and guide them when needed.

### 3. Method

To achieve the objectives of the study, a quasi-experimental design was used. This is due to its relevance to the nature of the study, where two groups were selected; the experimental group "*taught using the Mathway application through smart devices*" and the control group "*taught using the tradition method*". The study population included all the second year of secondary school students who study Mathematics -4- in governmental schools in Najran in the second semester of the academic year 1442 AH. As for the sample of the study, King Abdul Aziz Secondary School was chosen. Section (A) of the second year of secondary students in the school was selected as an experimental group totaling (41) students. Section (B) of the second year of secondary students was selected as a control group totaling (42) students. The two sections were previously randomized.

To ensure that the dependent variable (academic achievement) was not affected by other than the independent variable, the random distribution of students in the two groups (experimental and control) was confirmed; the distribution was previously randomized by the selected school, and the teaching process was conducted on the two groups within the same teaching period. Also, the teacher who carried out the experiment on the experimental group was the same as who taught the control group. In addition, the same tests were applied to the two groups; the pre-achievement test was applied to both the experimental group and the control group as well as to the post-achievement test.

In addition to the above, the two groups (experimental and control) were pre-tested. To ensure their equivalence in the academic achievement variable, the means and standard deviations of the pre-achievement test scores for the two groups (experimental and control) were calculated, and equivalence between the two groups was examined. Then, a t-test was used to find out the statistical significance of the differences between the students in the two groups in the pre-achievement test. The results revealed that the means of the experimental group in the pre-achievement test were 9.32 with a standard deviation of 2,285 whereas the means of the control group in the pre-achievement test were 9.57 with a standard deviation of 2,380. The value of (T) was (-0.496) with a statistical significance value of (0.621), which is greater than (0.05). Therefore, it is not statistically significant, and this indicates that the difference between the two groups (experimental and control) in the pre-achievement test did not have any statistical significance at a level less than (0.05). This means that the experimental group and the control group were equivalent in the academic achievement variable before the experiment.

#### 3.1 Instruments of the study

In this study, two instruments were used: a pre-achievement test and a post-achievement test. This is due to its relevance to the nature of the study. A guide was prepared to help the teacher teach the topics of the first unit of Mathematics -4- using Mathway as detailed in the following:



### **a. Pre-achievement test**

A pre-achievement test consisting of twenty items was prepared in the most important topics in mathematics before the second year of secondary school. To ensure that the two groups of study (experimental and control) are equal, the following is an explanation of how to verify the validity and reliability of the pre-achievement test and the appropriateness of items:

- The validity of the test was verified by a group of experts who were asked to provide their opinions and suggestions. Accordingly, the test was modified.
- The test was applied to an exploratory sample and the coefficients of difficulty were calculated and ranged between 0.275 and 0.525. Also, the discrimination coefficients ranged from 0.30 to 0.65. In addition, the reliability of the test was calculated using the Alpha Cronbach equation. The results indicated that the test reliability coefficient amounted to (0.847), an educationally acceptable coefficient. The reliability of the pre-achievement test was extracted using the half-segmentation method. The value of the overall reliability coefficient was (0.878), a very good statistical value that indicates the test reliability.

### **b. Post-achievement test**

The content of the first unit (relations and functions) was analyzed in Mathematics -4 – subject. After that, an achievement test consisting of twenty items was prepared according to a prepared specification table. This was to ensure the balance in the test and to ensure that the test measures a representative sample of the unit content (relations and functions) in the Mathematics -4- subject in which the achievement is intended to be measured.

- The validity of the test was verified by a group of experts who were asked to provide their opinions and suggestions. Accordingly, the test was modified.
- The test was applied to an exploratory sample and the coefficients of difficulty were calculated and ranged between 0,300 and 0,530. Also, the discrimination coefficients ranged from 0.30 to 0.75. In addition, the reliability of the test was calculated using the Alpha Cronbach equation. The results indicated that the test reliability coefficient amounted to (0.867), and educationally acceptable coefficient. The reliability of the pre-achievement test was extracted using the half-segmentation method. The value of the overall reliability coefficient was (0.879), a very good statistical value that indicates the test reliability.

## **3.2 A guide that helps the teacher to teach the topics of the first unit of Mathematics -4- using Mathway**

A guide was prepared to help the teacher, and the student uses the Mathway application. Also, it helps the teacher in teaching the topics of the first unit of Mathematics -4- using Mathway, using the ADDIE model according to its five stages: analysis, design, development, implementation, and evaluation.

### 3.3 Steps of experiment implementation

The steps included the following:

- 1) The teacher and students download the Mathway application on their smart devices. Then, they are trained on using the application by explaining all the functions contained in the application and the components of the branches in the application, and providing some examples of solving some problems.
- 2) The teacher starts to present the unit topics of relations and functions from Mathematics subject -4- using the prepared guide after judgment and making sure that it is free of errors.
- 3) The teacher prepares for each topic of the relations and functions unit from Mathematics subject -4- before teaching. Students are directed to use the Mathway application in learning the examples included within each topic of the relations and Functions unit from Mathematics subject-4- according to the order and sequence of the examples in the guide and understand each step and rationale in each example Mathway.
- 4) After students understand the steps of solving each example and make sure that they understand them well, the teacher directs them to do exercises similar to the examples that were explained using the application. This time, they do the exercises manually, and then they check whether their solutions are correct using the application.
- 5) In this step, the student self-evaluates his solution to the exercises using the feedback he received from Mathway concerning the correct steps for his solution and the steps where he made mistakes. Therefore, he corrects the mistakes and makes sure not to commit them when solving similar exercises in the future.

In all the previous steps, the teacher continues to support his students and facilitate the communication processes between him and the students, and between the students themselves. He answers their inquiries and solves the technical problems that students face when using Mathway.

## 4. Results and Discussion

To answer the main question in this study, its hypothesis was tested, which states: there is a statistically significant difference at ( $\alpha \leq 0.05$ ) between the means of the experimental group and those of the control group in the post-achievement test.

The value of the t-test was calculated between the means of the post-achievement test scores for the two groups (experimental and control). The test results showed the following values in Table 1:

**Table 1:** Means, standard deviations, and t-test for the experimental and control groups in the post-achievement test scores

Group	No.	Means	Standard deviation	P-value	Sig-tailed-2	Eta	Eta-squared	Effect size
Experimental	41	11.02	3.31	2.272	*0.026	0.245	0.060	Medium
Control	42	9.35	3.37					

\* Significant at the level of (0.05).

Table 1 shows that there was a difference between the mean scores of the experimental and control group in the post-academic achievement test. While the means of the experimental group students reached (11.02), the means of the control group scored (9.35). The value of (P) was (2,272) with a statistical significance value of (0.026), which is less than (0.05). This indicates that there was a statistically significant difference between the experimental and control groups in the post-academic achievement test in favor of the experimental group; the means was (11.02) compared to (9.35) for the control group. This result indicates that the experimental and control groups were not homogeneous in their scores in the post-achievement test; the students in the experimental group who studied using the Mathway application performed better in the post-achievement test compared to those in the control group who studied using the traditional methods of teaching mathematics. This means that the use of the Mathway application had a positive effect on developing academic achievement in mathematics among the second year of secondary school students in Najran in Saudi Arabia.

According to this result, the hypothesis of the study is accepted, which states: "There is a statistically significant difference at ( $\alpha \leq 0.05$ ) between the means of the experimental group and those of the control group in the post-achievement test." due to the method of teaching mathematics through the Mathway application.

Table 1 also shows that the Eta square is equal to (0,060) indicating that the effect size was medium. This reflects the effect of the independent variable "Mathway application" on the dependent variable "Students' academic achievement" was moderate. This result agrees with the study of Hadjinor et al. (2021) that revealed statistically significant differences between students' scores due to the teaching method "using the Mathway application" in favor of the post-test. The result also accords with that of Al-Blushi's (2018), which showed statistically significant differences among students due to the use of Mathway in favor of those students in the experimental group. In addition, the result of the current study is in line with those results by Al-Omeishat (2019), Alkhateeb and Al-Duwairi (2019), Alkhateeb (2019), Fabian et al. (2018), Mhlanga (2018), and Al-Bedouin (2017) that showed statistically significant differences between students. These results were attributed to the use of smart device applications in mathematics for the benefit of the experimental group. The study result is also in line with those of previous studies in its positive impact on the students' use of smart devices in teaching and learning in general and students' academic achievement in particular.

Moreover, the result of the current study is in agreement with those of the studies by Al-Zahrani (2019), Altaf (2019), Alyan and Al-Qasimiyah (2019), Klimova (2019),

Demir and Akpınar (2018), and Elfeky and Masadeh (2016). They revealed statistically significant differences between students due to the use of devices smart devices for the benefit of the experimental group of students, and the positive impact of their use on teaching and learning in general, and students' academic achievement in particular. Finally, this result is consistent with that of Quispe, et al.'s (2018) and Kattayat et al.'s (2017) studies that showed a positive impact of using smart devices on the processes of teaching and learning.

This result differs from that of Etcuban and Pantinople's (2018), which did not reveal any statistically significant differences between the students of the groups. However, the results agree on the positive impact of the use of mobile devices in general and smart devices in particular in supporting the educational process and enhancing student achievement and development and attracting their attention towards learning. From the foregoing, it is evident that the students of the experimental group succeeded over those of the control group in this study due to some reasons:

- 1) Teaching using the Mathway application is non-traditional; it changes the traditional learning environment in which the teacher is the only source of information to an environment in which students play an active role in accessing information.
- 2) Learning using the Mathway application helps reveal misconceptions or lack of knowledge that students have in solving and explaining some problems.
- 3) Students who learn using the Mathway application, their learning becomes meaningful. They realize the steps of solving problems through the application, their logical arrangement, and the understanding of what each step in the solution contains explanation and understanding of the operations between each step and the other. This makes the students' understanding faster and helps them to retain what they learn and facilitate the process of retrieving information when needed.
- 4) Learning using the Mathway application increases students' self-confidence and reduces their fear of mathematics in general and of making mistakes when solving problems in particular. This is because the Mathway application supports students after solving the exercises with a detailed explanation of the steps of the solution. This makes them know their correct and incorrect steps, and they self-evaluate themselves by noticing the mistakes they commit in solving the exercise and realizing the correctness of that without feeling ashamed of the teacher or their other classmates.

## 5. Recommendations

In light of the findings of the current study, it is recommended that:

- 1) The Mathway application and similar applications be used in the educational process such as the student's use of the Mathway application in explaining mathematical problems and checking their answers to the exercises due to their

positive effects in education, especially in developing students' academic achievement.

- 2) Teachers and students are trained on how to deal with smart device applications in mathematics in general and the Mathway application in particular.

### Conflict of Interest Statement

The authors declare no conflicts of interest.

### About the Authors

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