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Evaluation of Various Aspects of the 11th Grade Engineering Curriculum: A Mixed-Methods Study*

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This study explored a twofold evaluation of the engineering curriculum from the perspectives of teachers, supervisors, and field experts. It evaluated the extent to which certain curriculum elements were achieved in the curriculum and the level of perceived self-efficacy of the curriculum's teachers and supervisors. The study adopted a mixed-methods approach utilizing a sequential explanatory design. This design involved two semi-structured questionnaires that were applied to 112 teachers and supervisors (62 males and 50 females) while a semi-structured interview was applied to 12 teachers and supervisors as well as to seven engineering experts, both academic, i.e., university professors, and professional. The results revealed that the curriculum elements and the perceived self-efficacy were achieved on a "medium" level with (66.8%) and (67.2%), respectively. It was also revealed that there were no statistically-significant differences attributed to the gender variable. Furthermore, the study identified the advantages and disadvantages of implementing the 11th grade engineering curriculum of the Pathways System. Some of the main advantages were familiarizing students with the concept of engineering and its fields as well as introducing basic computer software. The disadvantages, however, were outlined as the lack of specialized teachers; the weak sequencing between the course and its prerequisite (physics); the inconsistency between the course description and its content; and the insufficiency of the practical part of the course and the necessary equipment for students to engage in engineering practices. As a result, the curriculum was found to be lacking in preparing students for the job market or the next educational stages including the preparatory year of university.

Keywords: engineering and computer science pathway; engineering curriculum; STEM; curriculum elements; self-efficacy

1. Introduction

As a pillar of comprehensive development, education has been central to Saudi Arabia's Vision 2030 with its ongoing endeavor to improve the educational system so that it keeps up with global advancement. The Human Capability Development Program of Vision 2030 highlights creating globally-competitive Saudi citizens through "developing a resilient and flexible educational base; preparing for the future labor market, locally and globally; and providing lifelong learning opportunities" [1, p. 11]; such goals are consistent with those of the UNESCO's sustainable development.

As a part of its quest to achieve these goals, the Ministry of Education launched the high-school Pathways System as an initiative to prepare students for the job market and the following academic stage, i.e., the preparatory year of university. The Pathways System consists of three years, the first of which is a foundation year where students study various, shared courses. The second and third years are shaped into five academic pathways: General; Life and Health; Computer and Engineering; Islamic and Law Studies; and Business Administration. Students are streamed into these pathways based on a formula that involves a student's GPA in the foundation year, the student's grades in the courses related to the pathway in which they want to enroll, and the student's score in the Vocational Interests Survey. Students who enroll in the Engineering and Computer Pathway study some courses which are related to engineering and computer science such as the engineering course at hand. The engineering textbook of the Engineering and Computer Pathway, the 2022 edition, consists of five chapters: Basics of Engineering, Engineering Circuits, Digital Circuits, and Electronic Circuits Simulation through Tinkercad Circuits [2].

Being a part of STEM education, teaching engineering in the K-12 stages has been perceived of differently in educational contexts. Some educational planners have pointed out that in K-12, engineering concepts can be taught independently; by being incorporated into other science courses; or through the STEM integrative approach where engineering concepts can be used as a linking point among STEM's fields [3–6]. There are also those who believe that science and mathematics can serve engineering by providing solutions for real-word problems [6-8]. Some educational studies have also stressed the importance of teaching engineering in K-12 as a booster of students' performance in science and mathematics. This is because,

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according to these studies, engineering increases students' technical knowledge, widens their understanding of scientific phenomena, equips them with the analytical skills necessary for scientific innovation, and ultimately prepares them for the jobs of the future [9–11].

As it gained momentum in the K-12 stages, engineering education has had a crucial role in designing and developing the K-12 science curricula from STEM education perspective as it is a main part of the Next Generation Scientific Standards [NGSS] [12, 13]. The NGSS indicates that students be familiarized with engineering design and that engineering practices be included in the science curricula of the K-12 stages [13]. In the context of Saudi Arabia, the Saudi Council of Engineers has issued the Professional Accreditation Guidelines which regulate the profession of engineering and outline the standards expected from engineering education. These guidelines stipulate those students be prepared for the job market by providing them with essential engineering knowledge, practices, and design processes. The guidelines also require offering engineering design courses that focus on scientific processes that can be implemented to solve problems, explain phenomena, as well as to test and evaluate hypotheses [14]. As a result, academic engineering programs in Saudi Arabia rely on these guidelines by offering courses in various engineering fields such as statics, mechanics, dynamics, fluid mechanics, electrical circuits, transport phenomena, engineering economics, and computer science.

Curriculum reform and development is an essential part of human development as curricula help shape students' minds, interests, and attitudes. Therefore, it is important that curricula undergo constant development according to society's needs and educational visions to ensure that they can provide students with knowledge, skills, and future competences. As a result, curricula should be aligned with curriculum frameworks, standards, directions, and parameters so that they are ultimately beneficial to learners [15]. Therefore, developing the Pathways-System engineering curriculum is a persistent necessity especially since the Computer and Engineering Pathway lacks a curriculum framework that provides curriculum and performance standards and achieves STEM's integration.

Central to curriculum development is curriculum evaluation. A number of areas can be evaluated in a curriculum which can cover (1) some curriculum elements such as objectives, content, activities, learning environment, evaluation, and textbook's specification; (2) the knowledge, skills, attitudes, and interests acquired by students; or (3) the effect on teachers in relation to professional development, self-efficacy, and the drive for teaching [16]. Due to the Computer and Engineering Pathway's lack of a curriculum framework and standards, this study evaluates the engineering curriculum in terms of two aspects. The first is the curriculum elements, i.e., the textbook's introduction; learning objectives; scientific content; learning activities; learning resources, equipment and aids; student evaluation; and technical specifications. The second is the perceived self-efficacy of teachers and supervisors.

The term self-efficacy, of the theory of social epistemology, refers to an individual's belief in their ability to achieve a certain task under certain circumstances [17]. This concept is manifested in a teacher's ability to perform their job duties and deal with various situations and challenges [18]. Self-efficacy has had considerable attention from education researchers as it impacts teachers' practices and the quality of the teaching process [19, 20]. Self-efficacy can also contribute to teachers' job satisfaction, help them overcome the difficulties they may face when dealing with students, and positively reflect on student performance [17, 21]. Furthermore, a teacher's self-efficacy plays an important role in their readiness and willingness to implement new curricula [19, 22, 23]. Ultimately, curriculum development would not be entirely effective unless it takes into account the role of teachers and the inclusion of teachers in decision making [24].

Teachers' inclusion in curriculum development is pivotal. Donaghue [25] indicated that teachers' perspectives and feedback influence new projects and programs as teachers along with education supervisors are the ones who actually implement them in the field. Accordingly, this current study relied on investigating the curriculum elements and self-efficacy from the perspective of teachers and supervisors. Additionally, the study takes into account the perspectives of academic and professional engineering experts. According to academic and professional experts, a curriculum should have some advantages, including its ability to help students identify various engineering majors, and its design and technical specifications that facilitate the understanding of engineering concepts [26].

Due to the recency of the engineering curriculum in the Saudi educational system and in light of the complete lack of studies in the Arab World that evaluated independent K-12 engineering curricula, this study stands as a valuable contribution to educational literature. The study reviewed previous studies that addressed the evaluation of the Pathways System in general; studies that evaluated some courses within the Pathways System; studies that tackled the inclusion of engineering practices in some of the Pathways System courses; and studies that targeted teachers' self-efficacy.

Reviewing physics as a prerequisite of engineering, Alahmad & Albogami [27] analyzed the content of the 11th grade Physics in Saudi Arabia in light of the NGSS. The analytic descriptive method was used to develop a content analysis coding sheet of the energy dimension of the NGSS's physical sciences standard. The sample was the third and fourth chapters of the 11th grade physics textbook. The results revealed that the level of inclusion of NGSS was low at (33.33%). Of the three dimensions of NGSS, the science and engineering practices was rated as the lowest at (16.35%). The study recommended that the reviewed content include more explanation construction and solution design of real-world problems.

The Education & Training Evaluation Commission [28] conducted a study that evaluated the preparatory year programs in Saudi universities and the Technical and Vocational Training Corporation. It aimed at gauging the skills of high-school graduates compared to those of the students who had finished the preparatory year. The study revealed that for the 2017–2018 academic year, students' average in the General Aptitude Test was (65.58), while it was (65) in the Academic Achievement Test for the Science Track with mathematics at (48.8), physics (53.2), chemistry (53.2), and biology (56.2), with notable differences in favor of female students. According to the students, what they studied at the preparatory year of university was mainly a repetition of what they had already studied at high school. The study recommended developing the high-school science and mathematics curricula so that they serve different academic programs at university.

In a study on the 10th grade chemistry textbook in Saudi Arabia, Aldahmash & Alfarraj [29] explored the level of inclusion of engineering design processes in the 2021-edition textbook which is introduced in the Pathways System. An analysis coding sheet was developed using an analysis rubric, and the unit of analysis was the activities and scientific experiments of the textbook. The results showed that the engineering design processes were included on a "novice" level and that the content did not meet the engineering design dimension of NGSS.

Al-Urayfi [30] conducted a study aimed at identifying the challenges that encounter the implementation of the Pathways System from the perspective of the high-school leadership supervisors and the school leaders in the Tabuk area. The study also investigated whether there were statistically-significant differences attributed to the job description and years of experience variables. A questionnaire was applied to 159 participants, and the responses indicated that the level of challenges ranged from medium to high and that there were no statistically-significant differences due to the aforementioned variables. The study recommended improving schools' readiness and infrastructure to accommodate the Pathways-System requirements as well as hiring specialized teachers for the newly-created courses.

In an evaluation of the high-school Pathways System according to the cognitive economy skills, the study of Al-Khathami [31] unveiled that the fulfillment of these skills was at a medium level with (73.28%). The curricular and extracurricular activities standard and the standard of educational technologies were fulfilled at a medium and low levels with (55.55%) and (20%), respectively. The recommendations were focusing on including practical skills and reconsidering the Pathways System in terms of the consistency between the system's theoretical framework and actual implementation.

In a quantitative study in the field of professional development, Alshehri [32] conducted a study to identify the training needs of high-school teachers in Saudi Arabia in light of the transition from the Courses System to the Pathways System. The results indicated that the teachers' need for training in all domains was at a medium level. Among others, there was a high need for teacher training in the content knowledge of the newly-introduced curricula; for training programs that target the phrasing of learning objectives and outcomes; and for the inclusion of technology in learning activities. The study found no statistically-significant differences between the responses that could be attributed to the gender and specialty variables. The study recommended providing training programs that target knowledge content and instill the culture of professional development.

Almymoni & Bunyaan [33] explored the challenges of implementing the high-school Pathways System and its prospects in meeting the demands of the Saudi job market from the point of view of high-school female principals. The descriptive method was used employing a questionnaire to collect data. It was revealed that the prospects of implementing the high-school Pathways System in meeting the demands of the Saudi job market were at a "neutral" level. The results also revealed that the participants strongly agreed that there were hindrances in implementing the Pathways System to meet the job market's needs, with the mean of the items under the hindrances dimension being (4.24). These hindrances were outlined as the lack of a comprehensive training plan for implementing the system; the inadequacy of the infrastructure; and the discrepancy between the graduates' skills and those demanded by the job market.

Under the umbrella of the NGSS, Alfarraj [34] examined the level of including sequential and separate engineering design processes in the 10th grade Pathways-System biology textbooks. Using descriptive analysis, an analysis coding sheet was designed to conduct the content analysis of the textbooks. The coding sheet covered the engineering design dimension with its eight indicators. The results indicated that the level of inclusion ranged between low and very low. The "identifying problems" and "designing solutions" indicators had a very low level of inclusion with (0.91%) and (2.28%) respectively. The study recommended developing the textbooks in light of the NGSS and including NGSS-aligned sequential and separate engineering design processes.

In the field of digital technology, Khyat & Basaleem [35] employed a mixed-methods approach to explore the challenges of teaching the theoretical content of the 11th grade Pathways-System Digital Technology curriculum (1–2) from the teachers' perspectives. A number of challenges were unveiled such as the difficulty of some of the course's topics; the weak integration between the course's units; the unavailability of the physical resources; and the literal translation of some of the course's terms.

As for self-efficacy, Benfer & Meehan [36] used the descriptive survey method to investigate the self-efficacy of a sample of American high-school teachers in relation to their teaching practices. The study found a positive correlation between self-efficacy and teaching practices such as student-centered learning, scientific investigation, and utilizing practical activities. The study also indicated that teachers with high self-efficacy implement technology more, were cooperative, and engaged in professional development opportunities. The study recommended promoting teachers' self-efficacy through targeted programs that enrich the teaching and learning processes.

Based on the literature reviewed above, it is evident that there has been a lack of studies which evaluated independent engineering curricula in K-12 in Saudi Arabia. Accordingly, this study serves as a much-needed contribution since it evaluates the curriculum elements of the 11th grade engineering curriculum of the Pathways System in addition to the perceived self-efficacy of the curriculum's teachers and supervisors.

2. Rationale and Questions

Ensuring that Saudi educational curricula are in accordance with global directions and the development requirements of Saudi Vision 2030, the Ministry of Education has offered a new engineering curriculum within the Computer and Engineering Pathway of the high-school Pathways System. This study was motivated by the novelty of this curriculum and the importance of curriculum evaluation as recommended by several studies [29, 34, 37, 38]. It evaluated the curriculum elements in the new curriculum and the perceived self-efficacy of its teachers and supervisors from their point of view, adding the perspective of engineering experts. It also aimed at unveiling whether there were significant differences that could be attributed to the gender variable. Gender was taken into consideration as a contribution to inspiring and empowering women to pursue engineering, and STEM, education [39] and in compliance with Saudi Vision 2030's goal of increasing women's participation in the future jobs of the STEM fields [40]. In achieving its objectives, the study sought the answers to the following questions:

1. At what level were the curriculum elements achieved in the 11th grade engineering textbook?
2. What is the level of teachers and supervisors' perceived self-efficacy in teaching engineering?
3. Are there statistically-significant differences between the means of the responses of the study sample in the level of perceived self-efficacy that are attributed to the gender variable?
4. How do the teachers, supervisors, and engineering experts evaluate the 11th grade engineering curriculum?

3. Significance of the Study

The significance of the study lies in that it could:

1. Attract the attention to the importance of the employment of educational integration in general and STEM integration in particular.
2. Inform the Executive Program for the Development of Pathways, Curriculum Plans, and Academies of the level of consistency between the engineering curriculum and other curricula in the Computer and Engineering Pathway.
3. Inform the Saudi Center of Curriculum Development of the strengths and weaknesses of the 11th grade engineering curriculum.
4. Help the National Institute for Educational and Professional Development identify the training needs for the teachers and supervisors of the engineering curriculum.
5. Help the Deputy Ministry for Scholastic Affairs identify the equipment, physical requirements, and infrastructure required for implementing the engineering curriculum.
6. Assist educators in assessing students' comprehension of engineering concepts and skills as

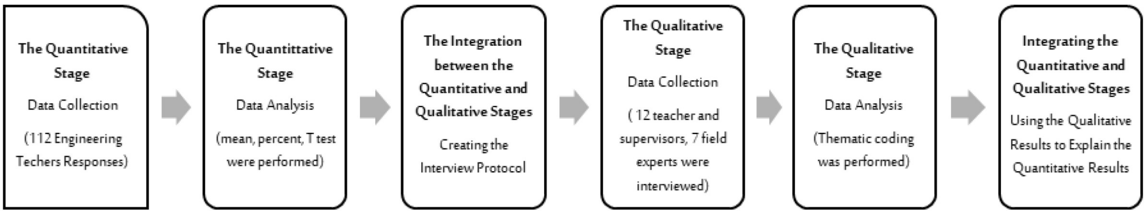

Fig. 1. Steps of the Explanatory Sequential Design.

well as identifying areas that require improvement. Additionally, the outcomes of the study can be used to develop tailored engineering curricula for high school settings that align with both local and global engineering education standards.

4. Methodology

The study employed a mixed-methods approach with an explanatory sequential design. This design consisted of three main stages as shown in Fig 1. The first was the quantitative stage in which the data were collected through two questionnaires. The second was the qualitative stage involving an interview for data collection. The third was the integration between the first two stages whereby the qualitative results were used to explain the quantitative ones. In this design, the integration of the quantitative and qualitative stages [41] helped establish a profound understanding of the study questions.

5. Study Instruments

Having reviewed the relevant literature, two instruments were employed to answer the study's questions: a questionnaire and an interview.

5.1 The Questionnaires

Two questionnaires were used. The first questionnaire targeted the evaluation of curriculum elements. It comprised 93 items that covered seven curriculum elements, namely the textbook's introduction; learning objectives; scientific content; learning activities; learning equipment, resources, and aids; student evaluation; and technical specifications. The second questionnaire consisted of 21 items that addressed the evaluation of the perceived self-efficacy of teachers and supervisors. Both questionnaires were applied to a random sample of 112 teachers and supervisors (62 males and 50 females). A five-point Likert Scale (strongly agree – agree – neutral – disagree – strongly disagree) was used in both questionnaires.

To verify the face validity of the questionnaires, they were refereed by 12 experts from the field of science education and were modified accordingly. The reliability, however, was verified using Cronbach's Alpha coefficient, applying the questionnaires to a pilot sample of 30 participants. The questionnaires had high-reliability coefficients of (0.97) and (0.93) respectively. Table 1 presents the Cronbach's Alpha values (α) of the questionnaires.

5.2 Interview

The second instrument was a semi-structured interview that was applied to 12 teachers and supervisors as well as to seven academic and professional engineering experts as detailed in Fig. 2. The participants were chosen based on personal willingness, geographical representation of all Saudi education departments, and having taught or supervised the 11th grade engineering curriculum of the Pathways System in the second trimester of the 2022–2023 academic year. Individual and focus-group interviews were conducted for periods of time ranging from 80–180 minutes. The interviews were transcribed and shared with the participants through Zoom to verify their comprehension of the study's questions. The interview addressed three dimensions: the advantages and disadvantages of the 11th grade engineering curriculum of the Pathways System; the curriculum's capacity in preparing students for the job market or university; and the challenges that face teachers and supervisors while implementing the curriculum. In addition to the dimensions above, the interview was meant to add the experts' perspective to that of the teachers

Table 1. Cronbach's Coefficient Values α for the Questionnaires

Sections and Subsections	Number of Items	Cronbach α Value of the Pilot Sample (n = 30)
Section One: Curriculum Elements	92	0.97
Textbook Introduction	8	0.89
Learning Objectives	14	0.87
Scientific Content	17	0.91
Learning Activities	17	0.92
Learning Equipment, Resources, and Aids	9	0.72
Student Evaluation	13	0.87
Technical Specifications	14	0.86
Section Two: Self-Efficacy	21	0.93

Table 2. Demographic Information of the Interview Participants

No	Code	Specialty	Job Title	Experience	Qualification
1	SM1	Physics	Education Supervisor	17	MA
2	TF1	Electrical Eng.	Female Teacher	7	BS
3	TF2	Physics	Female Teacher	14	BS
4	SM2	Physics	Education Supervisor	14	BS
5	TM1	Physics	Male Teacher	20	BS
6	TM2	Physics	Male Teacher	20	MA
7	TF3	Physics	Female Teacher	1	BS
8	TF4	Physics	Female Teacher	10	BS
9	TM3	Physics	Male Teacher	4	BS
10	TM4	Physics	Male Teacher	8	BS
11	TM5	Physics	Education Supervisor	15	BS
12	SM3	Physics	Education Supervisor	8	BS
13	EC	Engineering	Assistant Professor	14	PhD
14	EE	Engineering	Professor	28	PhD
15	FEE2	Engineering	Assistant Professor	11	PhD
16	FLE	Engineering	Engineer	21	MA
17	ENG	Chemical Engineering	Engineer	20	MA
18	FA	Planning and Architecture Eng.	Professor	30	PhD
19	FEE2	Engineering	Professor	28	PhD

Table 3. Characteristics of the Study Sample (N = 112)

Variable	Job Title		Gender		Years of Experience			
Category	Teacher	Supervisor	Male	Female	Less than 5 Years	5–10 Years	10–15 Years	More than 15 Years
Number	85	27	62	50	16	9	38	49
Percentage	75.9%	24.1%	55.4%	44.6	14.3%	8%	33.9%	43.8%

and supervisors to explain the results reached in the quantitative stage.

To ensure credibility and trustworthiness, triangulation was achieved through the variety of the data collection methods, researchers, and data sources. There were also the multiplicity of data analyses and data saturation, theoretically and conceptually. In addition, the interview's credibility and trustworthiness were guaranteed by recording the interviews, with the participants' permission, as well as transcribing and sharing the scripts via Zoom. A cordial relation was also established with the participants to ensure collecting accurate date.

6. Study Population and Sample

The study's population encompassed all the teachers and supervisors of the engineering curriculum in the second trimester of the 2022–2023 academic year, spread over the 256 schools which implemented the Computer and Engineering Pathway of the Pathways System [42]. The sample consisted of 112 teachers and supervisors (62 males and 50 females) who were randomly selected. Table 3 indicates the characteristics of the study's participants.

7. Data Analysis Procedures

7.1 First: The Quantitative Section

Descriptive method was applied to analyze the obtained data. The means, standard deviations, and percentages of the questionnaire's items were calculated using the SPSS software to answer the first two questions of the study whereas the T test was used to answer the study's third question. The means, standard deviations, and percentages of the responses were categorized into three levels: "high," "medium," and "low" as presented in Table 4.

7.2 Second: The Qualitative Section

To achieve a profound understanding of the qualitative data, they were analyzed using the case study approach. The analysis went through a number of stages starting with organizing the data, coding

Table 4. Levels of Achievement

Level of Achievement	Range	
	Percentage	Mean
Low	$46.6 \geq$	$2.33 \geq$
Medium	$73.4 \leq X \geq 46.7$	$3.67 \leq X \geq 2.34$
High	$73.5 \leq$	$3.67 \leq$

them, note taking, axial coding, and finally phrasing and confirming the results. The case study analysis relied on inductive analysis of the data which led to the final statements about evaluating the 11th grade engineering curriculum of the Pathways System.

8. Results

8.1 The Quantitative Results

8.1.1 The First Question

The study's first question was, "at what level were the curriculum elements achieved in the 11th grade engineering textbook?" To answer this question, the means, standard deviations, and percentages of each item of the seven curriculum elements were calculated as listed in Table 5.

Table 5 indicates that the curriculum elements were achieved in the 11th grade engineering curriculum of the Pathways System on a "medium" level with an overall mean of (3.34) and a percentage of (68%). The individual means of the curriculum elements: textbook's introduction; learning objectives; scientific content; learning activities; learning equipment, resources, and aids; and student evaluation were (3.48, 3.38, 3.42, 3.36, 3.43, 3.40) respectively. The technical specifications element, however, was achieved at a "high" level with a mean of (3.68).

As for the items, the ones that were achieved the most were "an engineering lab is required to perform some of the course's activities" at (4.38); "the textbook includes a table of contents that divides the content into units/chapters, and lessons" at (4.04); "each unit contains a list of the learning objectives" at (3.98); "the introduction introduces the book's chapters and units" at (3.97) "the introduction includes a brief description of the book" at (3.92). One the other hand, the indicators with the lowest achievement were "an engineering lab is available to perform the course's activities" at (2.85); "a fast internet connection is available to implement computer simulation activities" at (2.65); "the learning activities focus on engineering practices" at (2.88); "the content observes the even inclusion of various engineering fields" at (2.90); and "the objectives foster hands-on activities" at (2.95).

8.1.2 The Second Question

The study's second question was "what is the level of teachers and supervisors' perceived self-efficacy in teaching engineering?" To answer this question, the means, standard deviations, and percentages of the self-efficacy items were calculated as detailed in Table 6.

Table 6 shows that the level of perceived self-efficacy of teachers and supervisors in teaching engineering was "medium" with a mean of (3.36), a percentage of (67.2), and a standard deviation of (0.82). The means of the items ranged between (3.62–2.82). The items with the highest achievement were "I can utilize various teaching methods in explaining engineering concepts" at (3.62); "I find it difficult to write commands in the Python programing language" at (3.61); "I can use Tinkercad to create and modify electronic circuits" and "I am knowledgeable about the professions and job opportunities in engineering" both at (3.54); and "I can use the electrical circuits simulation software, Multisim Live" at (3.51). The items that were achieved the least, however, were "I am knowledgeable about De Morgan's Theorem" at (2.82); "I am knowledgeable about the concepts of polynomial algebra" at (2.95); "I am knowledgeable about truth tables" at (3.03); "I find it difficult to integrate engineering, sciences, mathematics, and technology in teaching engineering" at (3.11); and "I can use the steps of engineering design in teaching engineering" at (3.29).

8.1.3 The Third Question

The study's third question was "are there statistically-significant differences between the means of the responses of the study sample in the level of perceived self-efficacy that are attributed to the gender variable?" To answer this question, the T test was used to verify whether there were any differences at (α-0.05) as shown in Table 7.

The calculated T value was (0.257) which indicated the lack of statistically-significant differences that could be attributed to the gender variable As shown in Table 7.

8.2 The Qualitative Results

These results concern the fourth question of this study, "how do the teachers, supervisors, and engineering experts evaluate the 11th grade engineering curriculum?" The quantitative analysis of the interviews led to the classification of the responses into four dimensions:

1. The advantages of the engineering curriculum according to the teachers, supervisors, and experts.
2. The disadvantages of the engineering curriculum according to the teachers, supervisors, and experts.
3. The prospects of the engineering curriculum in preparing students for the job market or university.
4. The challenges that encounter the implementation of the engineering curriculum.

Table 5. The Means, Standard Deviations, and Percentages of the Curriculum Elements

Curriculum Element	No	Items	*M*	*SD*	%	Level of Achievement
First: Textbook Introduction	1	Includes the standards of the book	3.38	1.09	67.6	Medium
	2	Includes a brief description of the book	3.92	0.67	78.4	High
	3	Introduces the book's chapters and units	3.97	0.76	79.4	High
	4	Identifies various learning sources	3.45	1.02	69	Medium
	5	Explains how the book is used and benefited from	3.45	1.05	69	Medium
	6	Summarizes the objectives of teaching engineering in high school	3.38	1.13	67.6	Medium
	7	Addresses students, parents, and teachers	3.09	1.14	61.8	Medium
	8	Attracts the reader to the content of the book	3.32	1.11	66.4	Medium
	Total		3.48	0.82	69.9	Medium
Second: Learning Objectives	9	Each unit contains a list of the learning objectives	3.98	0.82	79.6	High
	10	The learning objectives accord with general objectives of high school	3.49	1.14	69.8	Medium
	11	The objectives are based on the standards of teaching engineering in high school	3.39	1.20	67.8	Medium
	12	The objectives are relevant to the needs of learners and local community	3.41	1.12	68.2	Medium
	13	The objectives observe the vertical alignment of curriculum design, i.e., the gradual progression of topics through the learning stages	3.08	1.24	61.6	Medium
	14	The objectives observe the horizontal alignment of curriculum design, i.e., the consistency of topics and courses within the same stage	3.10	1.16	62	Medium
	15	The objectives achieve the integration between knowledge branches such as sciences, technology, engineering, math, and arts	3.44	1.11	68.8	Medium
	16	The objectives observe the balance between knowledge, skills, and emotions	3.23	1.11	64.6	Medium
	17	The knowledge learning objectives are classified into gradual levels including recollection, comprehension, application, assembly, evaluation, and creativity	3.42	1.13	68.4	Medium
	18	The objectives help the learner choose or design proper evaluation tools	3.47	1.04	69.4	Medium
	19	The objectives accommodate learners' characteristics, abilities and needs	3.43	1.13	68.6	Medium
	20	The objectives foster engineering design	3.29	1.16	65.8	Medium
	21	The objectives foster hands-on activities	2.95	1.24	59	Medium
	22	The objectives foster minds-on activities	3.66	0.89	73.2	Medium
	Total		3.38	0.93	67.6	Medium
Third: Content	23	Accords with the course description	3.35	1.18	67	Medium
	24	Accords with the general learning objectives of the course	3.46	1.17	69.2	Medium
	25	Accords with the learning objectives of each lesson	3.60	0.93	72	Medium
	26	Provides the main engineering terms for each chapter/unit	3.78	1.01	75.6	High
	27	Promotes national identity and loyalty to Saudi Leaders	3.66	1.04	73.2	Medium
	28	Observes the balance in chapters/units in terms of lessons, activities, and exercises	3.45	1.09	69	Medium
	29	Observes the even inclusion of various engineering fields (chemical, industrial, mechanical, etc.)	2.90	1.38	58	Medium
	30	Highlights the importance of engineering applications in life improvement	3.42	1.17	68.4	Medium
	31	Addresses the steps of engineering design	3.29	1.18	65.8	Medium
	32	Highlights the relation to mathematics while dealing with calculations	3.62	1.02	72.4	Medium
	33	Provides various tasks that integrate other fields such as technology, sciences, mathematics, and arts	3.43	1.20	68.6	Medium
	34	Fosters attitudes towards learning engineering	3.56	1.11	71.2	Medium
	35	Highlights the central concepts of NGSS	3.48	1.06	69.6	Medium
	36	Includes technological alternatives and web links to each lesson	3.35	1.15	67	Medium
	37	Avoids unnecessary repletion	3.41	1.13	68.2	Medium
	38	Suitable for learners' abilities and capabilities	3.31	1.14	66.2	Medium
	39	Takes into consideration gifted and special-needs learners	3.15	1.16	63	Medium
	Total		3.42	0.92	68.4	Medium
Fourth: Learning Activities	40	The learning activities accord with the textbook's content and objectives	3.37	1.06	67.4	Medium
	41	Observe the balance between knowledge, skills, and emotions	3.25	1.07	65	Medium
	42	Focus on engineering practices	2.88	1.18	57.6	Medium
	43	Focus on knowledge and mental processes	3.60	0.94	72	Medium
	44	Foster inquisitive skills	3.40	1.02	68	Medium
	45	Foster scientific and engineering practices	3.39	1.12	67.8	Medium
	46	Provoke students' minds by presenting them with problems that represent phenomena	3.24	1.17	64.8	Medium
	47	Foster mathematical thinking	3.42	1.06	68.4	Medium
	48	Foster writing skills	3.01	1.22	60.2	Medium
	49	Foster engineering drawing skills	3.24	1.27	64.8	Medium

Table 5. (*cont.*)

Curriculum Element	No	Items	*M*	*SD*	%	Level of Achievement
Fourth: Learning Activities (*cont.*)	50	Motivate learners	3.58	0.96	71.6	Medium
	51	Enhance communication through cooperative work	3.70	1.07	74	High
	52	Relate to learners' environment and experiences	3.38	1.11	67.6	Medium
	53	Suitable for high school students	3.46	1.17	69.2	Medium
	54	Observe individual differences between learners	3.25	1.11	65	Medium
	55	Measurable and Assessable	3.58	1.03	71.6	Medium
	56	Implementable within the available resources	3.33	1.15	66.6	Medium
	Total		3.36	0.92	67.2	Medium
Fifth: Learning Equipment, Resources, and Aids	57	The teaching aids are related to the Curriculum objectives	3.63	0.90	72.6	Medium
	58	The teaching aids vary as pictures, drawings, and illustrations	3.68	0.95	73.6	High
	59	The teaching aids attract learners' attention	3.61	0.99	72.2	Medium
	60	The teaching aids are simple and error-free	3.34	1.05	66.8	Medium
	61	An engineering lab is required to perform the course's activities	4.38	0.94	87.6	High
	62	An engineering lab is available to perform the course's activities	2.58	1.37	51.6	Medium
	63	Learners are provided with the steps of accessing and using learning resources such as Multisim Live & Tinkercard)	3.83	0.93	76.6	Medium
	64	An interactive, electronic textbook which promotes independent learning is provided	3.21	1.24	64.2	Medium
	65	A fast internet connection is available to implement computer simulation activities	2.65	1.47	53	Medium
	Total		3.43	0.80	68.6	Medium
Sixth: Student Evaluation	66	Evaluation accords with the curriculum's objectives.	3.49	1.06	69.8	Medium
	67	Observes the balance between knowledge, skills, and emotions	3.33	1.10	66.6	Medium
	68	Enforces basic engineering concepts	3.41	1.05	68.2	Medium
	69	Encourages the application of engineering knowledge	3.40	1.08	68	Medium
	70	Enhances engineering higher thinking skills	3.37	1.12	67.4	Medium
	71	Promotes discovery and exploration	3.47	0.99	69.4	Medium
	72	Promotes cooperation among learners	3.54	0.99	70.8	Medium
	73	Evaluation activities are suitable for learners' capabilities	3.46	1.03	69.2	Medium
	74	Assessment methods vary as diagnostic, formative, and summative	3.29	1.12	65.8	Medium
	75	Evaluation questions vary as objective and subjective	3.67	0.87	73.4	High
	76	The textbook includes model answers for some exercises to allow independent learning	3.13	1.22	62.6	Medium
	77	The textbook provides standardized tests at the end of each unit/chapter	3.04	1.29	60.8	Medium
	78	Authentic assessment such as projects and reports, etc. is included	3.59	1.04	71.8	Medium
	Total		3.40	0.90	68	Medium
Seventh: Technical Specifications	79	The picture on the textbook's cover represents the book's engineering content.	3.59	1.08	71.8	Medium
	80	The colors of the textbook are similar to those used in other textbooks in the Computer and Engineering Pathway.	3.63	1.00	72.6	Medium
	81	The textbook includes a table of contents that divides the content into units/ chapters and lessons.	4.04	0.83	80.8	High
	82	The font used is suitable for learners' needs.	3.92	0.96	78.4	High
	83	The textbook includes high-quality pictures, figures, diagrams, and graphs.	3.89	0.95	77.8	High
	84	The pictures, figures, diagrams, and graphs complement the texts to which they are attached.	3.80	0.99	76	High
	85	The language of the textbook is suitable for learners' needs.	3.82	0.93	76.4	High
	86	The language is error-free.	3.46	1.11	69.2	Medium
	87	The textbook includes a table of contents that divides the content into units/ chapters and lessons.	3.97	0.87	79.4	High
	88	The presentation of content exhibits logical transitions between ideas.	3.58	1.10	71.6	Medium
	89	The presentation of content is clear and uncomplicated.	3.57	1.05	71.4	Medium
	90	There is a summary at the end of each unit.	3.19	1.17	63.8	Medium
	91	The chapters and units are interconnected.	3.49	1.11	69.8	Medium
	92	The content is suitable for the number of classes allocated for each unit/lesson.	3.54	1.05	70.8	Medium
	Total		3.68	0.81	73.6	High
	Overall		3.40	0.80	68	Medium

Table 6. The Means, Standard Deviations, and Percentages of Self-Efficacy

No	Items	*M*	*SD*	%	Level of Achievement
1	I am knowledgeable about engineering concepts and fields	3.40	1.13	68	Medium
2	I am knowledgeable about the professions and job opportunities in engineering	3.54	1.09	70.8	Medium
3	I am knowledgeable about the concepts of digital circuits	3.47	1.18	69.4	Medium
4	I am knowledgeable about the concepts of polynomial algebra	2.95	1.33	59	Medium
5	I am knowledgeable about De Morgan's Theorem	2.82	1.30	56.4	Medium
6	I am knowledgeable about truth tables	3.03	1.34	60.6	Medium
7	I can relate engineering concepts to learners' real-world experiences	3.44	1.24	68.8	Medium
8	I can utilize various teaching methods in explaining engineering concepts	3.62	1.22	72.4	Medium
9	In teaching engineering, I can utilize teaching strategies that motivate learners	3.50	1.19	70	Medium
10	I can use interesting teaching methods to teach engineering	3.48	1.22	69.6	Medium
11	I can utilize engineering practices in teaching engineering	3.40	1.25	68	Medium
12	I trust my capabilities in designing hands-on activities related to engineering concept	3.31	1.22	66.2	Medium
13	I trust my capabilities in designing mental-skills activities related to engineering concepts	3.45	1.14	69	Medium
14	I find it difficult to provide feedback on learners' performance and inquiries about engineering concepts that are not covered in the textbook	3.31	1.21	66.2	Medium
15	I can evaluate learners' engineering projects, design, and electronic models	3.40	1.08	68	Medium
16	I find it difficult to integrate engineering, sciences, mathematics, and technology in teaching engineering	3.11	1.26	62.2	Medium
17	I can use the steps of engineering design in teaching engineering	3.29	1.11	65.8	Medium
18	I can use digital technologies in teaching and learning engineering	3.37	1.13	67.4	Medium
19	I can use the electrical circuits simulation software, Multisim Live	3.51	1.19	70.2	Medium
20	I can use Tinkercad to create and modify electronic circuits	3.54	1.11	70.8	Medium
21	I find it difficult to write commands in the Python programing language	3.61	1.23	72.2	Medium
	Overall	3.36	0.82	67.2	Medium

Table 7. The T-Test Results

Gender	Number	*M*	*SD*	Degree of Freedom	T value	Level of Significance
Male	62	3.37	0.813	110	0.257	0.451
Female	50	3.33	0.833	103.9		

8.2.1 The Advantages of the 11th Grade Engineering Curriculum of the Pathways System

The study sample pointed out a number of advantages. The curriculum contributed to familiarizing students with the concept of engineering and provided a brief overview of its fields. In addition, the computer simulation activities enhanced students' motivation towards learning as teacher (TM4) stated that the curriculum "encouraged students to interact more than physics did perhaps due to the use of computer simulation." Similarly, teacher (TM2) claimed that "computer simulation software, after providing the necessary equipment, was motivating for the students."

The experts also highlighted some advantages such as the curriculum's overview of engineering majors well as the curriculum's design and technical specifications which aided in the comprehension of engineering concepts. Expert (FEE2) pointed out that "the pictures and illustrations covered, to a great extent, the written concepts" and that "adding colorful notes in textboxes helped students comprehend and remember them." The expert added that the curriculum helped enrich students especially with English scientific terms which "they would need in university and later in professional life." The interviewees agreed on the importance of including engineering in high school as this inclusion is in keeping with the global directions in this field.

Analyzing the 112 participant responses to the open-ended questions, the advantages of the engineering curriculum were classified as in Fig. 2.

8.2.2 The Disadvantages of the 11th Grade Engineering Curriculum of the Pathways System

Despite the advantages outlined above, there were several disadvantages, as indicated by the participants, that pose challenges to implementing the curriculum. One of the disadvantages was the lack of specialized teachers as the course was taught by physics teachers. Teacher (TM4), for example, pointed out that he "can teach the first two units of the book but not the rest" and that "teachers need training and development which are difficult to do independently due to the scarcity of learning resources in Arabic." Another teacher added that the course "relies on computer and digital skills with which physics teachers are unfamiliar." He also referred to "the difficulty of polynomial algebra for physics teachers as it is related more to mathematics and computer than it is to physics." Students' poor performance in the Python programing language was cited by 69% of the participants as a contributor to complicating the unspecialized teacher's job. Expert (FEE2) stressed that "physics teachers are unable to teach some topics" and that "the course needs electrical engineers or computer technicians since computer teachers wouldn't be able to teach the course without having studied electrical circuits."

Another disadvantage was the insufficiency of the physical resources and technical requirements for implementing the activities of the course. One teacher claimed that "there is no lab for engineering nor an internet connection." Another teacher corroborated this claim saying that "having a lot of programs to use in the course without having a strong internet connection or a computer lab" was a disadvantage.

In addition to the insufficiency of resources, there was the inadequacy of content sequencing. One teacher highlighted this point saying that in the engineering curriculum, "students study electrical and electronic engineering without having studied the basic concepts of electricity and semi-conductors." Teacher (TM3) added that "a lot of concepts were repeated in the 12th grade Physics" and that "such a physics course should be taught before engineering" after doing the necessary modifications that conform to the benchmarking in this field.

The inconsistency between the course's description and its content was frequently pointed out by the participants. The course, when this study was conducted, focused mainly on electrical and electronic engineering, neglecting other fields of engineering after providing just a brief overview of these fields at the beginning. Expert (EC) stated that the content "is limited to electrical and electronic engineering without tackling other fields such as petrol engineering which is essential in an oil-rich country like Saudi Arabia" while "unfamiliar fields were introduced such as municipal engineering." This idea was echoed by expert (FEE2) saying, "reviewing the course's description, one would expect each chapter of the course to cover a different field of engineering, but there is mainly focus on electrical engineering." Another expert (ENG) commented, "if I had been a high-school student studying this course, and I did not like electrical engineering, I would not have joined the college of engineering thinking that it only taught electrical engineering as the textbook did not introduce me to other fields of engineering" that would fit different interests and attitudes.

While the course focused on computer-simulation activities, it overlooked hands-on activities. Expert (FEE2) stated that "while computer-simulation activities are useful to students, they should not occupy almost half of the course that was supposed to cover engineering and its various fields." The expert also indicated that "it would be very useful for students to apply some of the basics of engineering in labs and not just concentrate on simulation software." This idea was reflected by a teacher who suggested that the course focused "too much" on software and websites that "could go out of use in the future" which would affect the course's content and structure.

Analyzing the 112 participant responses to the open-ended questions, the disadvantages of the engineering curriculum were classified as in Fig. 3.

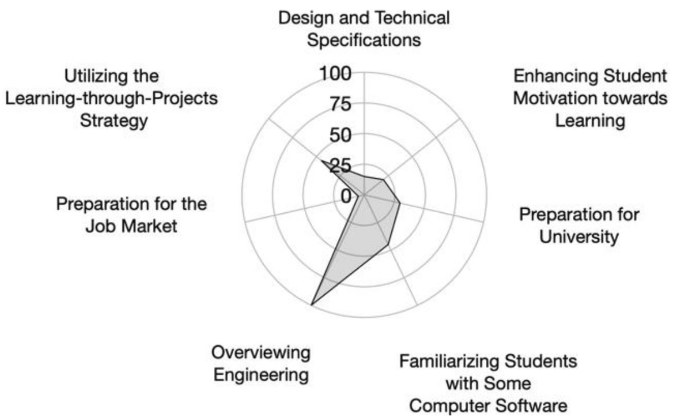

Fig. 2. The Advantages of the Engineering Curriculum according to Participant Responses.

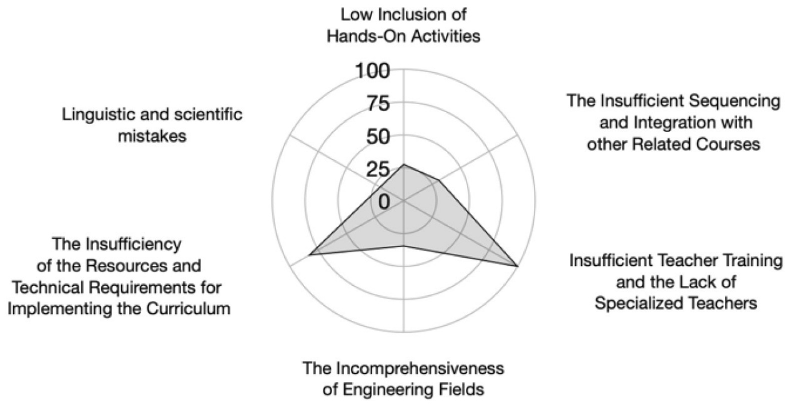

Fig. 3. The Disadvantages of the Engineering Curriculum according to Participant Responses.

8.2.3 The Prospects of the Engineering Curriculum in Preparing Students for the Job Market or University

The teachers, supervisors, and experts agreed, 80% of them, that the content of the engineering curriculum might not be effective in preparing students for the job market directly after high school. They suggested that the course did not target job-market preparation as it focused almost solely on computer simulation and some other topics which are not required in the work field. Expert (EC) explained, "it would be inaccurate to say that the course prepares students for the job market as it requires certain practical skills" which the course lacks. As for preparing students for the preparatory year of university, 75% of the participants found the course to be lacking. Expert (FEE2) pointed out that "the course does not prepare students for the preparatory year of university as students in that year study a number of courses, of which engineering is not one" and therefore "the course [as it was] has no equivalent in the preparatory year." As a result, the course would not be helpful should the preparatory year be dispensed with as the first year of university for engineering students.

8.2.4 The Challenges that Face the Implementation of the Engineering Curriculum

After analyzing the responses of the 112 participants, the challenges were classified based on their frequency in the responses into four categories as shown in Fig. 4. These categories are:

1. Challenges related to teachers' competence in the content knowledge of the engineering course.
2. Challenges related to providing the necessary educational environment such as equipment, resources, and infrastructure.
3. Challenges related to professional development.
4. Challenges related to teachers' competence in technological knowledge such as electrical circuits design and control circuits.

These challenges prompted the investigation of the professional development programs that targeted teachers and supervisors. It was revealed that 40% of the participants had not received any training despite the novelty of the course whereas only 30% were trained in the scientific content. Fig. 5 illustrates the training received by the teachers and

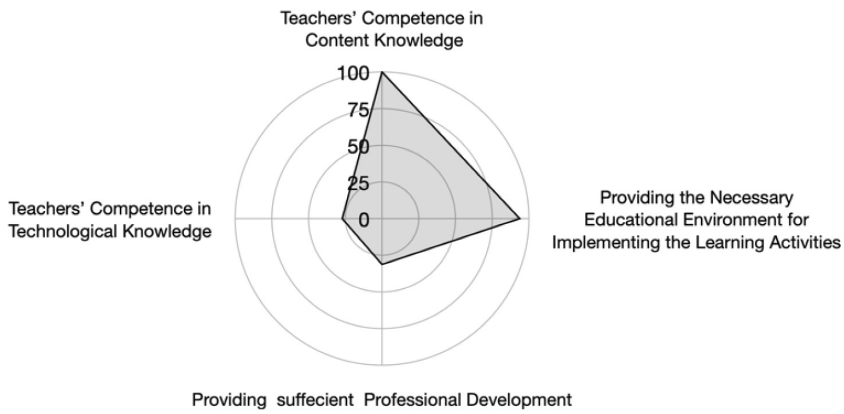

Fig. 4. The Challenges of Implementing the Engineering Curriculum according to Participant Responses.

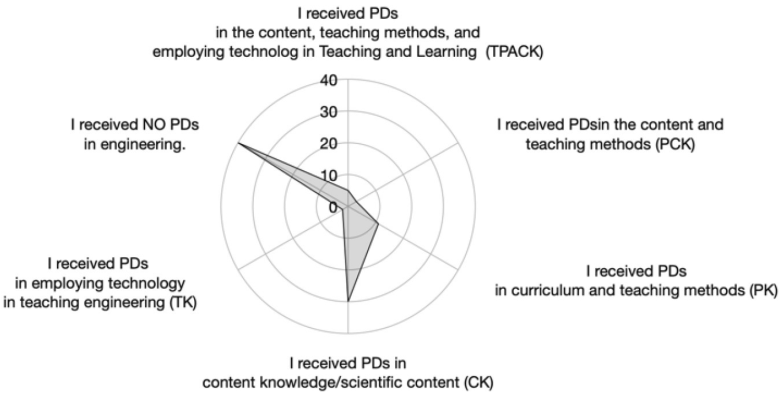

Fig. 5. Participant Responses to the Open-Ended Questions about Training.

supervisors where it can be noticed that the training strategy separated the educational and technological aspects from the scientific knowledge.

9. Discussion

This section addresses how the interview responses of the teachers, supervisors, and experts were utilized in explaining the quantitative results.

The results of this study revealed that the level of curriculum elements achievement was "medium" at (68%). Despite this medium level of achievement, the items that were achieved the most were minor items such as the course requiring a lab to do the activities, the textbook having a table of contents, the textbook's introduction reviewing the units of the textbook, the introduction describing the components of the textbook, and some of the textbook's technical specifications. On the other hand, several major items concerning the structure of the curriculum had a low level of achievement. Some examples were providing an interactive electronic book for independent learning; observing the vertical and horizontal alignment of curriculum design; fostering hands-on activities; covering all fields of engineering equally; and providing labs, resources, and equipment. To reiterate, important items had a low level of achievement while less important ones were achieved the most.

When it comes to observing the vertical and horizontal alignment of curriculum design, and despite its importance, it scored low in the questionnaire responses. This was consistent with the qualitative part where according to participant responses; it was the third most-recurring disadvantage of the curriculum. In a deviation from the vertical and horizontal alignment of curriculum design, the responses highlighted the dependency of the topics in the engineering curriculum on electrical physics that is taught in the 12th grade. This is perhaps due to the lack of curriculum standards that shape the structure of the Computer and Science Pathway. Designing curricula needs to be based on educational and national framework and standards that are consistent with the bases of curriculum design and society's needs [43, 44].

As for the inclusion of hands-on activities and engineering practices, these items scored low even though engineering practices are a major component of the NGSS. This result mirrored those of other studies [27, 29]. This low achievement of engineering practices could be explained by the third-lowest item, the "even inclusion of various engineering fields." The content of the engineering curriculum focused mainly on electrical and electronic engineering which rely on computer simulation even though the course description states otherwise. It states,

> "This course covers the basics of engineering through immersing students in engineering, starting with a historical overview of engineering and proceeding to highlighting the various engineering fields and majors such as the basics of electrical, mechanical, electronic, industrial, and civil engineering."

The description above clearly states that the content focuses on the basics of engineering in several, different fields. However, the content of the engineering course focuses only on electrical and electronic engineering. The experts highlighted this contradiction by suggesting that the course should be renamed as "the basics of electrical and electronic engineering" instead of just "engineering." The qualitative part tackled the low inclusion of scientific and engineering practices as the fourth most-recurring disadvantage. This result means that the engineering curriculum did not conform to the guidelines of the Saudi Council of Engineers [14]; the objectives of teaching engineering [45]; and the recommendations of the International Technology and Engineering Educators Association [46]. All these parties highlighted the importance of hands-on activities and engineering practices and the necessity of including them in engineering curricula.

Moving on to labs and equipment, the quantitative item, "an engineering lab is required to perform the course's activities" had the highest score of (4.38). Interestingly, the items "an engineering lab is available to perform the course's activities," and "a fast internet connection is available to implement computer simulation activities" were the lowest scoring. Even though simulation software can aid in the acquisition of engineering knowledge [47], these results showed that the engineering curriculum was based on computer software without providing its requirements. This was echoed in the qualitative part where the "the insufficiency of equipment, resources, and infrastructure to do the course's activities" was the most recurring disadvantage in the participant responses. This result corroborated that of Al-Khathami [31] which stated that the educational technologies dimension was achieved at a low level at (20%).

In terms of the self-efficacy of teachers and supervisors, the quantitative results indicated a medium level at (67.2%), with the item of utilizing "various teaching methods" having the highest score. In contrast, the items with the lowest achievement were the ones concerning: the difficulty of giving feedback to students and answering their inquiries about engineering concepts which are not in the textbook; using the steps of engineering design; integrating engineering, sciences, mathematics, and technology; knowledge of truth tables; the Python programming language; polynomial algebra; and De Morgan's Theorem. The Python programming language was especially challenging to teachers. These shortcomings can be attributed to the course being taught by unspecialized teachers. This interpretation is supported by the qualitative results where insufficient teacher knowledge was cited as the biggest challenge that faced teachers. This low level of teacher knowledge can be tied, as the qualitative results suggested, to the ineffectiveness of teacher and supervisor training.

To that point, Litowitz [48] claimed that teacher-training programs, pre and during service, tend to concentrate on educational knowledge while neglecting content knowledge which reflects on teachers' performance and as a result on students. Teacher development programs, particularly in science and technology, should train teachers in utilizing modern teaching strategies [49] and gaining solid content knowledge to enhance students' knowledge and skills [50]. Moreover, Gibson & Dembo [51] pointed out that teachers' self-efficacy influences their teaching practices whereby teachers with high self-efficacy direct their students and effectively correct their answers in a way that achieves concept comprehension. Several other studies stressed the importance of taking into consideration teachers' perceptions of training programs [52–54] since teachers' perceptions and beliefs directly affect their practices.

Discussing the engineering curriculum's capacity for preparing students for the job market or university, 80% of the teachers and supervisors thought the curriculum fell short of qualifying students for work directly after high school. Furthermore, 70% of them believed it is an inadequate preparation for university. This result was in accordance with [33] who found that the Pathways System's ability to prepare students for the job market to be at a "neutral" level.

When it comes to gender-related differences, none were found in the investigation of the self-efficacy of teachers and supervisors. This lack of difference can be due to the recency of the engineering curriculum, and the Pathways System in general. It can also be ascribed to the centralization of professional development programs that target both males and females equally. Another reason would be the similarity in male and female teachers' experience as the vast majority were not specialized in engineering. The lack of differences can also be understood in the context of teachers' study at university since both males and females study the same science and mathematics BS programs in Saudi universities, and therefor receive equal knowledge. The current results of this study support the idea that [55] there was gender equality in interest towards engineering fields between males and females. However, the result of the study differed from [38] who found female teachers to have higher self-efficacy in engineering design. The result, however, agreed with that of [30] and [32].

10. Recommendations and Implications

The study recommends reconsidering the current engineering curriculum and developing it in accordance with benchmarks such as the Framework for P-12 Engineering Learning [45]; the Framework for Quality K–12 Engineering Education [56]; the NGSS [13]; and the Professional Accreditation Guidelines of the Saudi Council of Engineers [14]. The study also recommends including engineering as an independent curriculum within the Saudi national framework of curriculum standards like other subjects such as sciences, mathematics, and English [57]. The study also recommends including NGSS-aligned engineering knowledge and practices in the Saudi K-12 science curricula, and doing so would mean dispensing with the first two chapters of the current engineering curriculum.

The results of this study can serve as a starting point for a number of future studies. A survey study could be conducted to determine the equipment, resources, and infrastructure needed to implement the engineering curriculum. Other studies could analyze the content of the engineering textbook in light of the NGSS as well as the vertical and horizontal alignment of curriculum design. The effect of including engineering in the Computer and Engineering Pathway on student performance in mathematics and science courses could also be investigated. Furthermore, there could be a study that examines the content of professional training programs to ascertain their compatibility with training standards. Finally, a tracking study could investigate the professional and academic prospects of the Computer and Science Pathway students.

11. Conclusion

The objective of this mixed-methods study was to present an evaluation of a high-school engineering curriculum in Saudi Arabia (N = 112) by considering input from teachers, supervisors, and industry experts. The results of the study revealed that the curriculum elements and the perceived self-efficacy were achieved at a ''medium'' level. The results also showed that there were no statistically-significant differences attributed to the gender variable. The study found that the engineering curriculum had several advantages, including familiarizing students with the concept of engineering and its fields as well as introducing basic computer software. However, the study also identified several disadvantages such as the lack of specialized teachers; the weak sequencing between the course and its prerequisite (physics); the inconsistency between the course description and its content; and the insufficiency of the practical part of the course and the necessary equipment for students to engage in engineering practices. The study concluded that the implementation of the 11th grade engineering curriculum of the Pathways System faced challenges including the structure of the course; providing and training specialized teachers; and providing the equipment and resources required for learning and teaching.

12. Study Limitations

The study was limited to exploring the opinions of (112) teachers and supervisors who participated in an electronic questionnaire while 12 teachers and supervisors as well as seven experts were interviewed via Zoom. The teachers and supervisors were chosen from the schools that implemented the Computer and Engineering Pathway in Saudi Arabia during the second trimester of the 2022–2023 academic year. The highest levels of accuracy and comprehensiveness were ensured in the qualitative and quantitative parts to achieve credibility and trustworthiness. Conducting face-to-face interviews was one of the limitations due to the geographical dispersion of the Computer and Engineering Pathway throughout Saudi Arabia. Despite these limitations, this study is considered a worthy contribution that tackles a contemporary research problem.

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