MODEL OF THE UNDERSTANDING OF THE NATURE OF PHYSICS, PEDAGOGICAL CONTENT KNOWLEDGE, AND ACHIEVEMENT MOTIVATION TOWARD STUDENT'S PREFERENCES OF PHYSICS AMONG TEACHERS IN OMAN

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SULTAN IDRIS EDUCATION UNIVERSITY

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" And the last of their call will be, "Praise to Allah, Lord of the worlds!"

ABSTRACT

The objective of this study was to model the contribution of understanding the Nature of Physics (NOP), Pedagogical Content Knowledge (PCK), and Achievement Motivation (Am) toward Students' Preferences for Physics (SPP) among teachers in Oman. The study also aimed to investigate whether Am has a mediating effect between the independent variables, which were gender, specialization and teaching experience. The sample comprised 523 teachers selected using a stratified random sampling technique from all governorates of Oman. Data were collected through a quantitative method utilizing a questionnaire and analyzed using Structural Equation Modeling (SEM-AMOS) software. The findings indicated significant positive relationships among NOP, PCK, Am, and SPP. The results demonstrated that both NOP and PCK significantly influenced SPP among teachers. Furthermore, Am was found to mediate the relationships of NOP, PCK, and SPP. Gender and specialization of respondents significantly moderated the relationship between NOP and SPP, while teaching experience did not have a significant moderating effect in this model. Conversely, teaching experience significantly moderated the relationship between PCK and SPP, whereas gender and specialization vice versa. In conclusion, NOP, PCK, Am and SPP were represented as the NPCKSP Model (Nature of Physics, Pedagogical Content Knowledge, and Achievement Motivation towards Student's Preferences for Physics). This study implies that the NPCKSP Model can be used to assess the quality of NOP, PCK, and Am in relation to SPP among teachers, particularly in Oman.

MODEL KEFAHAMAN SIFAT FIZIK, PENGETAHUAN PEDAGOGI KANDUNGAN DAN MOTIVASI PENCAPAIAN TERHADAP KEUTAMAAN FIZIK PELAJAR DALAM KALANGAN GURU DI OMAN

ABSTRAK

Objektif kajian ini adalah untuk memodelkan sumbangan Kefahaman Sifat Fizik (NOP), Pengetahuan Pedagogi Kandungan (PCK) dan Motivasi Pencapaian (Am) terhadap Keutamaan Fizik Pelajar (SPP) dalam kalangan guru di Oman. Kajian ini juga bertujuan untuk mengkaji sama ada Am memberi kesan pengantara hubungan antara pembolehubah bersandar iaitu jantina, pengkhususan dan pengalaman mengajar. Seramai 523 guru dipilih menggunakan teknik persampelan rawak berstrata yang terdiri daripada guru dari kesemua wilayah di Oman. Data dikumpul melalui kaedah kuantitatif menggunakan soal selidik dan dianalisis menggunakan perisian Permodelan Persamaan Berstruktur (SEM-AMOS). Dapatan menunjukkan hubungan positif yang signifikan antara NOP, PCK, Am dan SPP. Keputusan menunjukkan kedua-dua NOP dan PCK mempengaruhi SPP secara signifikan. Tambahan lagi, Am menjadi pengantara hubungan antara NPK, PCK dan SPP. Jantina dan pengkhususan responden memoderasi hubungan antara NOP dan SPP secara signifikan, manakala pengalaman mengajar tidak memberikan kesan moderasi yang signifikan di dalam model. Namun begitu, pengalaman mengajar memoderasi hubungan PCK dan SPP dengan signifikan tetapi tidak bagi jantina dan pengkhususan. Kesimpulannya, NOP, PCK, Am dan SPP diwakili oleh Model NPCKSP (Kefahaman Sifat Fizik, Pengetahuan Pedagogi Kandungan, Motivasi Pencapaian dan Motivasi Pencapaian terhadap Keutamaan Fizik Pelajar). Kajian ini memberi implikasi bahawa Model NPCKSP boleh digunakan untuk mengakses kualiti NOP, PCK dan Am terkait dengan SPP dalam kalangan guru khususnya di Oman.

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4IR	Fourth Industrial Revolution
AAAS	American Association for the Advancement of Science
AAPT	American Association of Physics Teacher
AM	Achievement Motivation
ASU	A' Sharqiyah University (OMAN)
BE	Basic Education
ETS	Educational Testing Services
GCC	Gulf Cooperation Council
MOE	Ministry of Education (OMAN)
NAS	National Academy of Science (USA)
NOP	Nature of Physics
NRC	National Research Council (USA)
OMREN	Oman Research and Education Network
PCK	Pedagogical Content Knowledge
PSSC	Physical Science Study Committee (USA)
SEM	Structural Equation Modeling
SMK	Subject Matter Knowledge
SPP	Students' Preference of Physics
SQU	Sultan Qaboos University (OMAN)
TIMSS	Trends in International Mathematics and Science Study
UN	University of Nizwa (OMAN)

UPSI	Sultan Idris Education University
UTAS	University of Technology and Applied Sciences (OMAN)

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter presents the study background and clearly underlines the problem statement. The purpose of the study is also discussed in this chapter. Moreover, the present chapter constructs three main objectives, three main research questions, and ten hypotheses to ensure the findings of the study are well supported. It also describes the research framework that has been developed to represent the relationships between the variables involved in the research framework. In addition, the chapter demonstrates the education system in the Sultanate of Oman, with key features of its education culture and the science teaching background. Finally, the chapter addresses the significance, limitations, operational definitions, and structure of the current study.

1.2 Education System in Oman

Sultanate of Oman, like any other country in the world, seeks to develop its educational systems in line with the latest scientific and technological developments. The official education process in Oman started in 1970 with a general education system. This system was divided into three levels of study, starting with the primary level, which involves six classes. The second level is the preparatory level, which involves three classes, and the third level is the secondary level, which involves another three classes. The teaching of science in this system characterized that the student after the first grade in secondary school can choose between two types of study in the post- basic extends to two years. The two types were namely the scientific section and the literary section. For the scientific section, a student must choose all science subjects (physics, chemistry, and biology) as compulsory subjects, in addition to mathematics. The public education system in Oman continued until 1998 when a new basic education system was introduced.

The need to develop education and raise its efficiency in view of the challenges of the century allowed the Sultanate to adopt the basic education system in a balanced and integrated framework that is concerned with linking theory and practice. This development in the education system played a significant role in providing the minimum basic knowledge and skills that enable learners to continue education and prepare them to continue their education in the following stages or to join the work according to their preparations, potential and competencies. The basic education system in Oman has been implemented since the academic year 1998/1999, with a duration of ten years. It is divided into two levels, and then the student moves to post-basic

education, which has a duration of two years (Ministry of Education, 2003). Table 1.1 shows the education structure in Oman.

Table 1.1

Education structure in Oman

Education system	Education stage	Period (years)	Levels	Students' ages (years)
Before 1998	primary	6	Class (1-6)	6-11
	Preparatory	3	Class (7-9)	12-14
	secondary	3	Class (10-12)	15-17
After 1998	Basic education	10	Level 1 (1-4)	6-9
			Level 1 (5-10)	10-15
	Post-basic education	2	Grade 11	16
			Grade 12	17

1.2.1 Basic Education Concept

Basic education is a unified education provided by the state to all sons and girls who are school-age of the Sultanate of Oman for ten years. Basic education aims to provide students with basic educational needs of information, knowledge, skills, values, and trends that enable the student to continue learning and training according to their tendencies, aptitudes, and abilities (Ministry of Education, 2003). In addition, this type of education also aims to develop student's abilities to meet the challenges and conditions of the present and the aspirations of the future within the framework of comprehensive societal development. By reviewing the current study of the basic

education system in the Sultanate of Oman, the study noted that basic education is concerned with:

- Complementarity between theory and practice, linking education to the reality of life.
- Comprehensiveness in the development of aspects of the student's personality in a balanced and integrated framework.
- Provide students with self-learning skills and focus on the concept of continuous education.
- Instill the values and practices needed to achieve mastery at work.
- Addressing human development needs in the context of inclusive community development.

1.2.2 Science Education in Oman

Many organizations around the world are interested in teaching and learning science in their various disciplines due to the direct correlation between their outputs and the needs of the labor market, as well as to the daily decision-making processes of individuals and institutions, which are mainly based on applications resulting from the integration of scientific and mathematic principles with other fields such as engineering and technology.

Generally, science education has been of interest locally and globally. It requires continuously developing the curriculum commensurate with the requirements of the

21st century, which is characterized by increasing knowledge and significant development in all fields of science. Natural sciences are directly related to humans in their practical applications, in terms of the environment and its problems, food, pollution, or the need for renewable clean energy sources, and it is also supporting technological progress. Therefore, science education is greatly affected by this rapid progress of knowledge. The development of science curricula in Oman has taken place in various stages. Science curricula in Oman have adopted several programs and fundamentals, including the Integrative Methodology, the American Standards of Science Teaching Methodology, the approach of STEM, and the Cambridge Science and Mathematics Program (Al Balushi, 2010). The change in the education system in the Sultanate of Oman has brought about a significant change in the teaching of science subjects. It has included all aspects and material and human resources related to science subjects, starting from the teacher, the curriculum, the teaching methods, evaluation strategies, and even the schools' construction. This change started with the implementation of the basic education system in Oman. The system allowed students at the end of basic education in 10th grade the freedom of choice among the subjects of various sciences to study in post-basic education, which last for another two years (Ministry of Education, 2014).

1.2.3 Philosophy of Science Education in the Sultanate of Oman

The education system of the Sultanate of Oman is very interested in teaching science in its various disciplines. The education document for science education in the Sultanate emphasizes the importance of science and its applications. Building the knowledge and

technology society, developing scientific research and innovation, all principles associated with science education and the National Education Strategy and the Oman Vision 2040 emphasize the importance of attention to educating young people about scientific research and developing innovation skills, which are directly linked to science education.

In general, the philosophy of education in any educational system reflects the needs and aspirations of society, combining its authenticity, values, history, reality and future. It explains the concepts and directions of educational institutions, frames the major educational goals and objectives at the national level, sets out strategies for the development of the educational system (Abu Jalala & Abadi, 2001), and covers the philosophy of the educational system in all national educational fields (Nwafor, 2014).

The Philosophy of Education Document of the Sultanate of Oman (Education Council, 2017) emphasizes the importance of science and its applications, the building of the knowledge and technology society, and the development of scientific research and innovation, all of which are principles and directives governing science education in its various disciplines. The philosophy of science education in the Sultanate of Oman is three principles of the sixteen principles of education philosophy (Al Balushi, 2010). Thus, the philosophy of education in the Sultanate of Oman prioritizes what serves the teaching of science subjects. Perhaps the thirteenth principle of scientific research and innovation has been confirmed in a set of objectives and guidelines advocated by international standards and organizations specializing in science and mathematics education, including the philosophy of science education goals in the Sultanate of Oman. These objectives are:

i. Develop higher thinking skills.

ii. Provide learning environments that stimulate thinking, exploration, scientific research and innovation.

iii. Developing scientific research and survey skills.

iv. Promote a culture of scientific research and innovation among learners and members of society.

v. Attention to and support for innovators and researchers in the field of science.

1.2.4 Preparation of Science Teachers

Advanced educational systems pay great attention to teacher preparation, and it consider teachers who know and master their specialization subject, and its teaching mechanisms are one of the main possibilities for the development of the education system. Furthermore, these systems also consider that human resources in the field of education also need to be continuously developed. Educationally, there is a continuing need to raise the learning quality in general and to raise the attainment level in particular. In the same context, the advanced countries endeavor to demonstrate the educational profession attractive and renewed in order to continuously reform teacher training and training processes, with a view to improving teaching performance within the classroom and developing their level of progress in the profession, helping them to have a positive impact on students' learning and their perception of students' preference for studying the subject. In this regard, reforms of teachers' training and professional development programs tend to focus on so-called professionalism through a range of

scientific, meditative, and investigative expertise related to before and during service (McMahon, Forde, Dickson, 2015).

In the Sultanate of Oman, the preparation and professional development of science and mathematics teachers is evolving. Science teachers are prepared in several higher education institutions. The preparation process is being followed up in these institutions to be compatible with international standards. In addition, science teachers have various opportunities for professional development during service, through workshops and training courses, or by providing them with the opportunity to complete their higher studies inside and outside the Sultanate. In addition, a national teacher training center has been established to train newly recruited teachers as well as experienced teachers and to provide them with various training programs.

Fortunately, science education is not limited to the formal curriculum. The Ministry of Education implements several programs that concern various aspects of science and its various disciplines. Examples include the Knowledge Technology Programme, the Scientific Olympiad, the Oman Science Festival, the Globe Global Environmental Programme, the STEM Oman Programme and the Green Schools Programme. Several institutions and centers also contribute to developing the knowledge and skills of students in science. The most prominent of these institutions are innovation centers, the Children's Museum, the Astronomical Dome, the Emerging Ecology and Exploration Centre, the Mathematics Genius Centre, and the Engineering Village. The Sultanate of Oman also has several projects aimed at upgrading science teachers and teaching science. These include the Study of Factors Affecting Students' Scientific Performance Project in the TIMSS Test, the School Garden Design Project,

the Conceptual Error Survey Project in Science, the Virtual Laboratory Project and the Gifted Science Development Project (Al Balushi, 2019).

In contrast, there are a range of challenges to learning and teaching science in the Sultanate of Oman, including poor performance in international testing, a gap between men and women in performance in science, delayed adoption of national standards for science teachers and their curricula, inadequate training programs for science teachers, and limited training programs for teachers on recent developments in curricula and evaluation. In addition, there are other challenges, as mentioned in Al Baluchi (2019), including one related to the level of some science teacher training programs, while some levels of science teacher training programs in the Sultanate enjoy international recognition from professional associations for the specialization of science and adherence to international standards; however, the other some of the level of preparation programs is simple and lacks a number of fundamentals such as adequate field training, the allocation of teaching staff so that every academic specialized in a field of science teaches his a specialty to students.

1.3 Background of The Study

In recent years, the world has witnessed a wide revolution in the evolution of physical science through its theories and applications to meet the requirements of human life and the human's need to describe, interpret and control natural phenomena and to invest those processes in achieving his needs, meeting the challenges, and making progress in different sectors.

Education is essential to all people and societies, and it defined as the process by which the aspects of the human personality are developed in all its aspects, whether cognitive, emotional, or psychological. When crises emerge in a society, many calls and movements call for the need for reform and renewal for community institutions and activities to move in new directions in response to those crises. The educational system in the world has recognized the importance of the role of the teacher in the educational process. They are keen to provide all the necessary resources for preparing him, including educational and professional qualifications, as well as pre-service and in-service training, regardless of the state of the schools. Although all these elements are essential, they remain of limited utility if there is a lack of efficient teachers. Therefore, it is necessary to pay attention to the conditions of the teacher and his training and qualifications (Hussein, 2014). The teacher is the first to be taken care of in such circumstances, where preparing the teacher academically is one of the most critical demands for the profession. Scientifically, caring for the teacher is one thing that is a must in all stages of education and scientific disciplines (Physics, Chemistry, Biology and Earth Science) because the teacher is the central pillar and factor in the educational process on which success is dependent (Gharaiba, 2006).

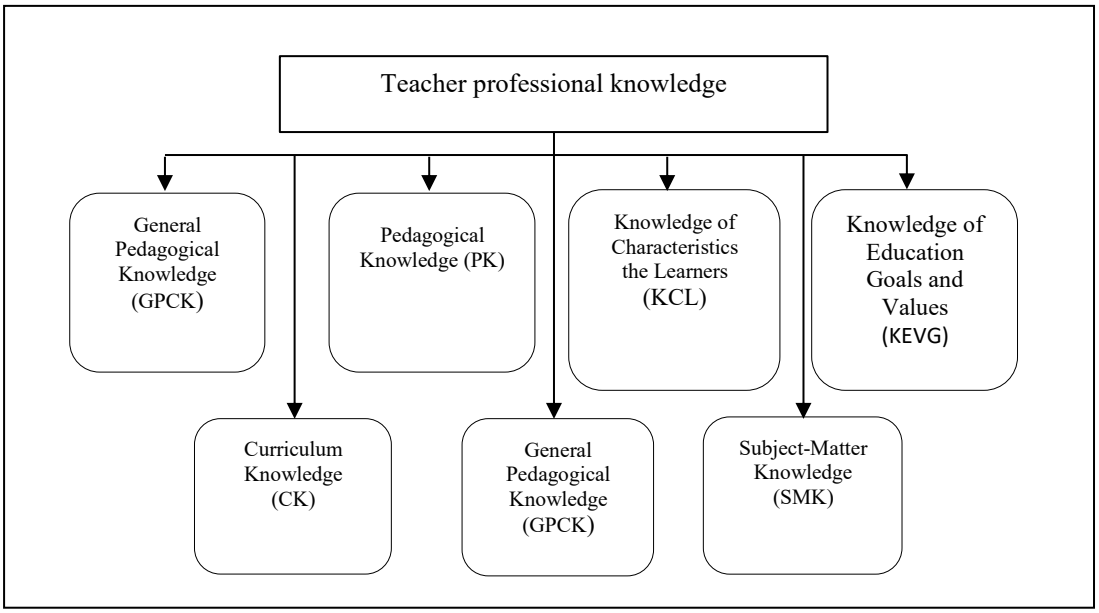
Educationally, the process of teaching science is generally based on a broad base of knowledge, combining knowledge with science and knowledge of educational principles (Van Dijka & Kattmann, 2007; Puteh at el., 2015). Carter's definition, referred to by Verloop, Van Driel, & Meijer (2002) and Van Driel et al. (1998), is that the teacher's knowledge is the overall knowledge of the teacher at a specific moment, the underlying behavior, and the teacher's knowledge of the nature of his work, and it lies in everything related to his educational activities, inside and outside the classroom.

Historically, an appropriate knowledge base for a science teacher was formed at the end of the last century, when Schulman (1986) began publishing his article on Subject Matter Knowledge (SMK), which has two main components: The first is to identify the strategies that are used to teach content and help to understand it, which appear from the research and practical experience. The second component includes the teacher's knowledge of the characteristics of the students, the alternative concepts they hold, and the difficulties the learner experiences in learning science. Also, in the same article, Shulman (1986) introduced Pedagogical Content Knowledge (PCK), which became part of the subject knowledge (SMK) (Al-Ramahi & Rawagah, 2018).

Shulman (1986) examined the teacher's knowledge of what he knows, what he needs to know, the sources of his knowledge and their organization, the impact of his teaching, and how that knowledge is used in teaching. He also divided the knowledge of the science teacher into three categories: Subject-Matter Knowledge (SMK), General Pedagogical Content Knowledge (GPCK), and Content Knowledge (CK). Shulman then added four new categories in 1987: pedagogical content knowledge (PCK), Knowledge of Characteristics of Learners (KCL), Knowledge of the Education Context (KEC), and the knowledge of Educational Goals and Values (KEGV). Hence, there are seven categories of professional knowledge for the teacher (Shulman, 1987). The current study explains the seven types of knowledge the teacher needs in teaching, as mentioned by Shulman (1987); Figure 1.1 illustrates the types of knowledge needed by the teacher in teaching according to Shulman 1987.

Figure 1.1

Type of Knowledge needed by teachers to Shulman, 1987



Shulman (1987) defined Pedagogical Content Knowledge (PCK) as the use of simulations, metaphors, examples, illustrations, and presentations to make the subject understandable to students. Gess-Newsome (1999) defined it as the most advantageous form of content representation. The most practical examples, explanations, presentations, interpretations and presentations, as well as a unique mixture of scientific content and teaching give the teacher a distinctive and well-managed way of absorbing the scientific subject adapting it to the educational situation, and the individual differences of learners. Gauthier, James, Curby, and Tarr (2003) defined it as a set of works that the teacher uses within his functions: knowledge transfer functions. Siyam (2014) defined PCK as the transformation of academic content into learnable content among a group of students studying at a particular school.

Educationally, the use of the term pedagogical content knowledge by Shulman (1986) has led to the knowledge that the teacher needs to be able to teach students. The

use of the term pedagogical knowledge of content has become synonymous with what we should know and understand to make a particular topic easy or difficult (Al Awadhi; Abdullah, 2019). The various sciences sought to benefit from pedagogical content knowledge in all its branches and specializations. As a result, several sciences and models specialized in teaching specific subjects emerged. For instance, the Technological Pedagogical Content Knowledge TPACK emerged, addressing all areas of digital and technological education knowledge.

Hence, based on the world's development that calls for the integration of all science with knowledge, attention to scientific knowledge has become necessary, so many studies have emerged that are concerned with increasing the efficiency of scientific materials teachers and providing them with the competencies and skills needed to develop their work on the one hand, and to keep up with scientific development on the other. All that to prepare a teacher with skills and knowledge to keep pace with scientific progress and cognitive development in all scientific disciplines in general and physics in particular for physics teachers. Adapting some models that have been interesting in the pedagogical content knowledge models, such as Koehler & Mishra's technological pedagogical content knowledge model (Koehler & Mishra, 2009, p. 66) to the current field of study, found that attention to the Pedagogical content knowledge of the nature of physics NOPCKs is an abbreviation of the phrase Nature of Physics Pedagogical Content Knowledge, which refers to knowledge in three key areas (physics, Pedagogical, and content), a framework for understanding and describing the types of knowledge that teachers need for effective pedagogical practices in a physically enhanced learning environment (Al-Saadi, Adnan, Ayop, 2020; Etkina, 2010). Generally, the model consists of three knowledge:

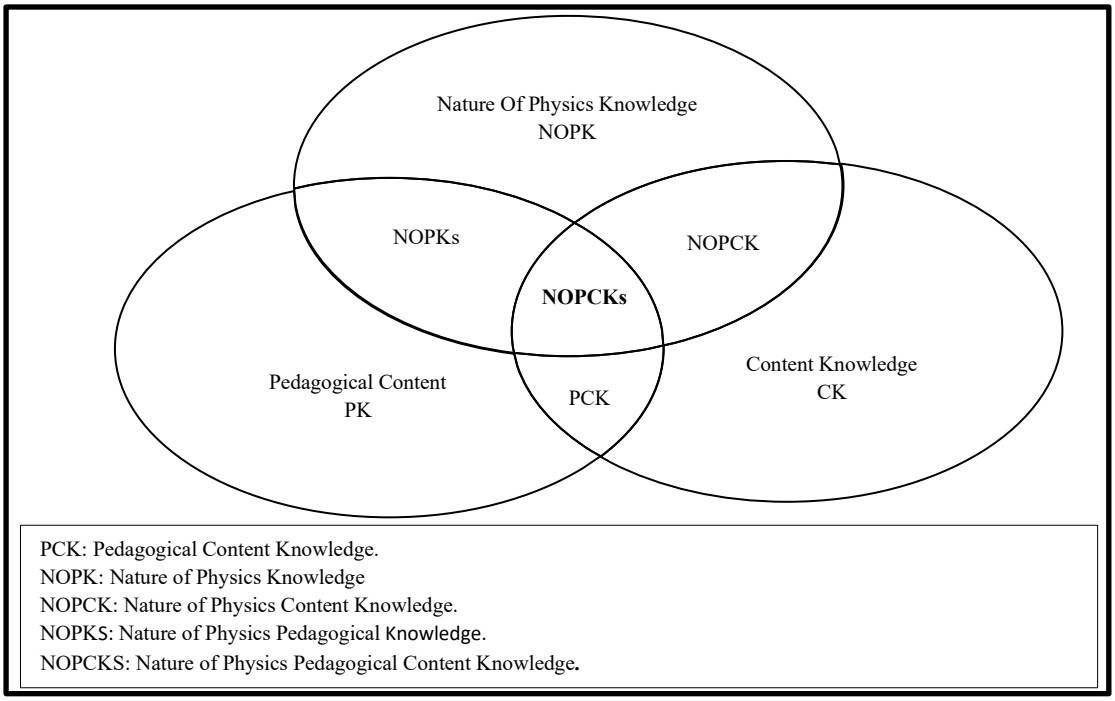
i. Knowledge about education (PK): The organization of the classroom administration, the general knowledge of learning theories and methods of teaching content.
ii. Content knowledge (CK): The teacher's knowledge of the scientific subject.
iii. pedagogical content knowledge (PCK): The basic knowledge that teacher preparation programs seek to develop.

The researcher considers that science teachers in general must develop comprehensively their knowledge regarding the nature of the subjects they study. In particular, 10th-grade science teachers must pay attention to the pedagogical content knowledge of the nature of physics as an essential requirement besides the essential teacher's specialization, which the teacher helps to teach physics subjects in the science book in a way that helps students to accept the scientific subject of physics adequately. Scientifically, this is done through the interaction between various components of the NOPCKs model, which includes knowledge of the nature of physics (NOP), Education Knowledge (PK), Content Knowledge (CK), Physical Content Knowledge (NOPK), Pedagogical Content Knowledge (PCK), this makes effective education with physics possible (Al- Ramahi; Rawagah, 2018).

In general, the nature of physics pedagogical content knowledge of (NOPCKs) is required by science teachers when teaching physics subjects. Therefore, by reviewing the literature on pedagogical knowledge of content in general and physics in particular, the researcher reached a summary of the pedagogical knowledge model of the nature of physics (NOPCKs) was proposed, which can be illustrated in the figure 1.2.

Figure 1.2

Model of the Nature of Physics Pedagogical Content Knowledge



Pedagogically, by reviewing the literature on current study variables, this study has generally benefited from (Marifa et al. (2023); Choudhary, Noor & Javed (2021); Al-Saadi, Adnan, Ayop (2020), Jacob et al. (2020); Widodo (2017); Wahbeh, Abd-El-Khalick (2014); Usak et al. (2011); Koehler & Mishra (2009), and Halim, Meerah (2002) in general and from the Al- Ramahi and Rawagah (2018) study in particular in adapted the model of the Nature of Physics Pedagogical Content Knowledge which illustrated by the figure 1.2.

Figure 1.2 shows a three-point intersection showing the types of knowledge that relate to content, pedagogical, and the nature of physics: PCK expresses the intersection of knowledge of content and how to teach it using pedagogical strategies commensurate with this content which is called Pedagogical Content Knowledge. NOPCK reflects the

intersection of content knowledge with physical knowledge to represent knowledge for content specializing in physics. With this knowledge, the teacher must be familiar with the topics of physics to judge their suitability for achieving an educational goal, which comes to deepen the knowledge content, called the Nature of Physics Content Knowledge. NOPKs express the intersection of pedagogical physics knowledge to represent knowledge of an urgent change in education and learning using knowledge of physics content and specific pedagogical methods, called the Nature of Physics Pedagogical Knowledge. NOPCKs express the intersection of all past knowledge and reflect the synchronization of knowledge of physics content and pedagogical knowledge, called the Nature of Physics Pedagogical Content knowledge.

It is worth mentioning that, to access this knowledge, teachers must have specialized knowledge and skills in the content itself and appropriate physics knowledge of this content with knowledge of the ways to employ the nature of physics so that it can effectively teach the content. Based on the previous and based on the fact that the 10th grade is of particular importance in itself, Therefore, physics teaching needs a science teacher with sufficient knowledge of the nature of physics and appropriate skills to help him develop his students' knowledge and increase their acceptability of physics, achieving the aims of teaching science subjects to 10th grade students depends primarily on the teacher and his motivation of education (Keller, Neumann and Fischer, 2017; Singh, Granville and Dika, 2002). Preparing a science teacher is no longer random but based on scientific-based planning (Ministry of Education, 2021)

Basically, students pose different abilities, needs and interests, but everyone needs to be able to use science in their personal lives, work, and study. All students have the right to feel the importance of science that enables them to make good use of resources, accurately interpret natural phenomena and be able to represent scientific concepts, which they acquire in various forms (American Association of Physics Teachers, 2002). Despite the importance of all subjects of science in general, teachers still believe that physics is the most difficult subject in scientific disciplines because of the mix of abstract and unique logical sequences that differ from other branches of sciences (Pantiwati, Wahyuni, & Permana, 2017; Usiskin, 2002). Studies on teacher's knowledge for effective learning are few. Maribah et al. (2007) stated that the teacher must have a deeper understanding of the content of the subject along with knowledge of theories of teaching to help integrate the subject into planned teaching.

From the education point of view, the world is witnessing an unprecedented interest in reshaping school and teacher's roles based on structural and social constructivist ideas. The role of teachers is no longer merely a keeper of the system and a transfer of knowledge, but rather a guide to the learning environment. For instance, in 1991, one of the largest American companies founded modern schools called Futures Schools. One of them was called Break the Mold School, which was named because it is unconventional as it relies on the principles of structural theory and Vygotsky's ideas in education (Jack 2017; Siyam, 2014). Based on the new educational trends that emphasize to change both the learner and the teacher, the teacher must be able to play these roles, must have sufficient scientific background on how the learner learns and learn deeply about the educational content and knowledge of the process of learning and teaching skills content. The teacher's knowledge of the content of the material, how

to teach, knowledge of the curriculum, students' ideas, and assessment methods has been combined under the term Pedagogical Content Knowledge (PCK), focusing attention on this knowledge and becoming important for effective learning (Shulman, 1987). Much research has been done on different aspects of teacher's knowledge of content (CK) and Pedagogical Content Knowledge (PCK), including the impact of teacher knowledge on the subject (Goos, 2004) and previous knowledge, and its impact on the construction of new concepts (Roschelle, 2001). In addition, research has been conducted on problem-solving methods, cognitive beliefs among teachers, and their impact on their knowledge of pedagogical content knowledge (PCK) (Keller; Neumann& Fischer, 2017; Etkina, 2010; Hausfather & Rainer, 2005).

In the same manner, the development of interest in pedagogical content knowledge (PCK) and the theories of learning have also evolved. Structural theory has even emerged, and it is based on the main idea that the knowledge of the person is built cumulatively; the learners build their new knowledge on the basis of previous learning. The constructional perspective is not a concept individually, but can include different insights, as identified by Kanselaar (2002):

i. A set of cognitive beliefs, such as beliefs about nature and truth.
ii. A set of psychological beliefs about learning and mind.
iii. A set of educational beliefs about pedagogy, and the best ways to support it, such as allowing learners to define their goals.

The new concept of instructional competence means that active teachers need pedagogical content knowledge (PCK) not only knowledge of the material, which is

not enough to be an expert in the learning material but to be able to help others to learn it (Brannsford et al., 2000). The effectiveness of education lies not in the teacher's personal knowledge, but in how this knowledge is used in class. This was demonstrated in a comparative study of the teachers of the United States and China conducted by Ma (1999) on teachers' understanding of the fundamentals of mathematics in China and the United States in order to investigate the causes of decline US students while Chinese students have passed the Trends in International Mathematics and Science Study (TIMSS) exam for several years. The results of the study indicate that the reason for this decline is related to the understanding of teachers, noting that the understanding of teachers in the United States was superficial compared to the Chinese teachers were more understanding of the mathematics and teaching methods. This is despite the knowledge of teachers in the United States was higher than the knowledge possessed by Chinese teachers. It also showed that each teacher, whether a beginner or experienced, has a degree of this knowledge and affects the amount and type of knowledge the teacher possesses in everything he teaches, how he teaches him, and how effectively he communicates with his students (Mohlouoa et al., 2012). Several educational studies have been agreed, including (Ambosaidi, Al-Hajri, 2013 & Verloop, et al., 2002) that knowledge of the pedagogical content of the teacher influences student achievement and increases their motivation to learn the material.

Generally, many countries, such as the European Union, China, Japan, Malaysia and Thailand, have adopted a new concept in their educational system: "lifelong learning for the teacher". So, in order to make the teachers professional and knowledge-based, they must engage in continuously developing professional practice (Siyam, 2014; Al-Khubati, 2003). In view of the Omani Economy 2020 vision, the Sultanate

has been keen on developing advanced Omani human resources with capabilities and skills in line with technological development and management of change in all fields, especially the field of education (Ambosaidi & Al-Shuaili, 2010; Issan, & Atari, & Alani, 2007). It may be noted that confirmed by the ' vision of Oman 2040 ' in continuing to focus on the educational system, starting with the teacher and paying particular attention of the teaching of science (Future Foresight Forum, 2017). Moreover, Ministry of Education in Oman has focused on scientific subjects, developing them and keeping them in line with the modern orientations in science education.

To sum up, the science curriculum in the Sultanate of Oman is based on modern scientific methods such as exploration and investigation and focused on the students (Ministry of Education, 2013). It also sought to take care of the teacher from the early stages of preparation in the institutions of higher education before service and follow-up training during the service through the development of training programs well-considered and effective, working to guide the teacher and guidance to methods and appropriate methods of teaching, and how to deal with the learner and the curriculum. These programs include academic and professional knowledge related to aspects of psychology, assessment, classroom management, curricula, teaching methods, and the use of modern technology in teaching (Ambusaidi and Al-Shuaili, 2009).

In the same topic of the nature of physics, the American Association of Physics Teachers (AAPT, 2002), published the basic lines of physics programs in the secondary stage based on the standards of science teaching, pointing out that the physics teacher must possess a strong physics knowledge in the topics of physics. In 2015, the PRAXIS

group published standardized tests of the physics skills, concepts, and knowledge that a physics teacher needs to teach physics. The most important topics are mechanics, electricity and magnetism and their applications, light and sound waves, thermal energy and thermodynamics, modern physics, knowledge of scientific inquiry and methods of research (Educational Testing Services ETS, 2015).

In short, the best person leads the process of teaching in a scientific and technical way is the teacher, who has the intellectual and educational thoughts, loves his profession, a familiar with the theories of teaching, possesses the competencies of teaching, and understands the nature of the subject. Additionally, the teacher must lead the motor, verbal and mental skills for students by different strategies and methods, which lead to scientific development. As a result of educational development, scientific leaps occurred in the field of physics and chemistry, such as the emergence of quantum physics and the emergence of advanced technology in science. This was accompanied by the emergence of many problems and crises that affected different aspects of life in society. Therefore, it became essential to study the nature of physics and its philosophy and related controversial issues among scientists and philosophers throughout the ages and to focus on teaching and imparting. This allows teachers to become an essential part of their practices in educational institutions, to prepare individuals capable of keeping abreast of scientific and technological development, coping with daily life problems that face them, and interacting with the surrounding environment.

In order to have excellent students in physics, teachers must know about the nature of physics. Physics education is a basic science that contains many abstract concepts, which are difficult for students to understand as these concepts mean fully.

Physics is based on the study of behavior and relations between a wide range of physics concepts and phenomena. By learning physics, students acquire these concepts and attitudes toward physics (Slaughter, Bates, & Galloway, 2012; Bajpai, 2012). Many educators pointed out that one of the most important reasons for students' reluctance to study physics, have no interest, and avoid studying it is the lack of using modern and varied teaching methods (Keller; Neumann & Fischer, 2017). Generally, teaching of physics is no less than being filled with students' theoretical knowledge through memorization. For that, most of teachers and curriculum developers have sought to find new ways to help students understand difficult concepts (Almazidi, 2017; Abdul Hamid, 2015; Cohen, 2013; Droui, 2012; Abasa, 2012; Drake, 2009; Za'ani, 2007). Basically, given the reality of physics teaching and the disparity between science teachers in general and physics teachers in particular, it is not necessary for a teacher to have a great deal of intelligence or excellence to be successful in teaching and his ability to communicate information to students and communicate effectively with them in academic intelligence and excellence (Za'ani, 2007; Reif, 1995). In contrast, they enjoy the admiration of their students and their satisfaction and passion for their participation and good behavior in critical situations and social relations with their colleagues and students alike. This discrepancy can be attributed to the understanding of the nature of physics mastery of scientific subjects and diversity in teaching methods (Mohammed, 2013; Mistades, 2008).

Unfortunately, some Omani studies showed that the current status of teaching physics in Oman is based on teachers’ interest in providing a large amount of scientific knowledge for students with a little emphasis on training students to solve the issues (Al-Kalbani, Al-Adili, 2020; Almazidi, 2017; Alsabrih, 2015). This is contrary to the

nature of physics, which is based on surveying, thinking, understanding, and linking with natural phenomena and interaction with the issues of society. It may be noted that we also observed, through the reality of visits and observations of physics teachers, that the current status of teaching physics in Oman confirmed the above-mentioned findings. Therefore, the researcher believe that it is necessary to pay attention to the teacher by raising his competencies and improving his teaching skills. The teacher may have high intelligence, advanced scientific qualifications, various degrees and courses, but he may not have the appropriate application of attractive interaction skills with his students to create active positive relationships with them and with their peers. Therefore, the creative teacher must use various skills in the senses, gestures, and representations of verbal language and body in teaching practices. This helps communication to be more effective, steadier, and stable in students, leading to effective teaching and improved student learning. The imbalance in the student's dependence on one's senses is dealt with without the other. The teacher can apply a variety of strategies to serve this in view of his understanding of the nature of science, and that needs teacher understanding for PCK (Lederman et al., 2012).

As confirmed by some educational research that, when physics is made inaccessible to school students, almost always through information overload, they tend to resort to memorization to pass examinations and this, in itself, seems to generate negative attitudes towards physics" (Mbajiorgu, & Reid, 2006). Therefore, the researcher believes through his observation of his supervisory visits to physics teachers as senior teacher of physics, these preferences and attitudes may be well formed in the early stages of secondary education because of a weakness in the level of the concept of the nature of science of physics among physics teachers**.** Thus, the researcher sees

the importance of further studies and research that will raise the level of understanding of the physics teachers of the nature of physics. To determine the level of relationship between Pedagogical Content Knowledge (PCK) and science materials in various disciplines, the researcher found some studies that included science subjects such as (Ambosaidi, & Al-Hajri, 2013), which aimed to assess the importance of PCK knowledge among science teachers in Oman, the results indicated that knowledge of the science learner was ranked first, knowledge of teaching strategies ranked second, and ranked third and final axis of knowledge in the science curriculum. The study of Karısan, Senay, & Ubuz (2013), sought to detect (PCK) in some subjects of physics in the teachers of physics in Turkey, and indicated that the results of the knowledge of teachers goals and objectives of physics and previous knowledge of students were good, and that teachers use different methods of teaching. It also showed that physics teachers in assessment strategies, lack of varied sources in school. A similar study by Angel, Ryder, & Scott (2005), which aimed at learning the nature of PCK in physics teachers, learners, and teaching strategies, showed that experienced teachers were more educational than beginner teachers.

According to some studies, the researcher agrees with Ali, & Mumni (2010); Etkina (2010); Ornek, Robinson & Haugan, (2008); Abd-El-Khalick, & Lederman (2000), that the educational systems that bear the responsibility of preparing the emerging need to be continuously reviewed, in order to improve their internal competencies by choosing the best inputs consistent with the educational reality. This is to allow the outcomes of the systems to meet the level of ambition of the society. The movement based on competencies is relatively valid for all stages and subjects, an active movement that makes teachers more positive and effective in influencing their

students, which is due to their large and important role within the school. In addition, teachers, the nature of science, teaching strategies, and implementation methods have an important impact on students' learning, the development of their preferences and attitudes toward the subjects, and their motivation toward learning.To confirm that specialists in educational psychology believe that the motivation of students to learn influences teachers, both in terms of the relationship between them and the learner, or in terms of their role in promoting students' attitudes and preferences to learning, the immediate intervention of the teacher in classroom situations has to do with the motivation of achievement (Choudhary, Noor and Javed, 2020; Musante, 2005, & Orpen, 1994). The weakness of the teacher's skill in presenting the scientific subject is often a source of reduced motivation for students toward learning (Al-Dho, 2010; Qubajh, 2004; Groham, & Millette, 1997).

Gorham and Christophel (1992) conducted a study on a sample of 308 students. The study found that 20% of them attributed the motivation to learning to teacher behavior and 19% to the design of the lesson and the situation in which it is presented. In the same study, when analyzing the responses of the sample regarding the factors that reduce the motivation of students and their preferences towards learning, it was found that 37% of the respondents attribute motivation to the teaching method, 34% to teacher behavior, and 29% to personal factors. The researcher concludes that students' preferences, attitudes, and motivations toward learning can be influenced by the teacher's behavior, experience and interaction with students within the classroom environment. In addition, other factors that can play a role are the type of educational environment, the need to specialize in a particular field and the diversity of classroom activities. The student direct feedback, accepting friends and colleagues, and provide

information about the progress of the learner, are important factors as well as pointed out by (Gorham and Millette, 1997). Therefore, this study is interested in examining the variables of the current study to see their effect on education in general and physics education in particular.

As that educational studies and modern international projects such as the American Association of Physics Teacher (AAPT), National Research Council NRC (1996), (National Science Teacher Association [NSTA], 2000), and Project 2061: American Association for the Advancement of Science AAAS, (1995), the development of the science curriculum in general and physics in particular indicate a weakness in the level of teachers' understanding of the nature of science. Further studies were recommended to raise the level of understanding of the science teachers of the nature of science and PCK, including: (Al-Tamimi, & Rawaqa, 2018 ; Al Janabi, 2016; Abdal Majeed, 2014; Alswelmyeen, & Rashed, 2013; Mohlouoa et al., 2012; Lin, & et al.,2012; Ferreira, & Morais, 2013; Al-zobi, 2011; Al-Issa & Huda , 2010; Etkina, 2010, and Holbrook, & Rannikmae, 2007). The follower of the educational literature on the methods of teaching science finds that the study of the preferences of students towards the study of science and the factors that affect their acceptance of the study of science subjects are studied in general, and the educators emphasize that the use of modern and effective teaching strategies and diversification in teaching usually lead to the quality of education and affect trends Students towards learning (Afifi, Taha, Ahmed, & Al-Moji, 2015, Cibik, & Yalcin, 2011). Trends are defined as: a set of cognitive, emotional, and behavioral components that relate to the individual's response to a cause, subject or position (Zayton, 2014). Hamdan (2006) defined trends as a case of nervous and psychological readiness that regulates the person's experience and has a directional

effect on the individual's response to all the subjects or situations that excite the response. Trends play a large role in the learner's life as a motive of his behavior in his various areas of life. The importance of knowing the individual's attitude toward a particular subject is to predict the behavior of the individual towards this subject (Sobh and Al-Ajlouni, 2003). Therefore, it is necessary to focus on developing students' attitudes towards science subjects through diversifying teaching strategies based on the teacher's understanding and experience, so the researcher sees the need to help the physics teacher in developing his students' preference in physics.

According to reviews of previous Arab and foreign studies in the field of emphasis on the importance of understanding the physics teacher of the nature of physics, we can say that there is a rare focus on this aspect in research. This is evidenced by the lack of studies and sources that address the importance of understanding the physics teacher of the nature of physics in the educational process. This may be one of the reasons, in my view, which led to the reluctance of students in the Arab world in general and Oman in particular to the choice of physics in the study after the post-basic education. On the contrary, most developed countries are keen to pay attention to the importance of understanding the physics teacher of the nature of physics due to recognition of the importance of the study of physics by members of society. This can be noticed in the teaching of physics through different sectors of life, including the educational sector, political, economic and media sectors. This is not what we find very much in our Arab countries (UNESCO, 2008). Hence, we can say we need to progress in this area through the qualification and upgrading of physics teachers to enable them to understand the nature of physics so that the teacher can provide the scientific material in a way that is enjoyable and loving to students and touches the life of the student and

bring the scientific material from reality to the environment of the student. As physics deals with certain facts that may be far from the concrete daily reality of life that a student may deal with directly it requires certain mental levels. Therefore, the researcher believes it is necessary that the educational policies should be in keeping with the new aspirations in educational learning science by focusing on the teaching practices, especially with regard to the nature of understanding science, as well as building a true depth of knowledge of the teaching concept to form a strong framework for teaching with strong educational rules.

Educationally, understanding the nature and philosophy of science, and understanding the origins of science education are inextricably linked and form part of the basic knowledge base that a science teacher is supposed to possess to teach science well. Thus, the present study agrees with some studies in this area, such as Al-Omri Study (2006), that science education requires a science teacher to have an appropriate understanding of the nature and philosophy of science and to recognize his or her role and that of his or her students in the study of science. Educators emphasize the need for the science teacher training programme to encompass three key areas. The first is scientific preparation, which includes scientific materials to be studied by a science teacher and fall within his scientific specialization, which he will be taught; the second is professional preparation, which includes courses on science teaching methods; and the third is general cultural preparation.

We do not deny that some Arab countries realized this and started planning it through short and long-term policies for all fields of life, including education. In this context, The Sultanate of Oman, through the Oman Vision of 2040, aims to develop the

system of subjects science and mathematics in general and physics in particular, as referred to by the Future Foresight Forum (2017). Based on the results of scientific research and previous studies and recommendations, stressing the importance of understanding the nature of science and Pedagogical Content Knowledge among science teachers is important in teaching physics and learning in order to adapt to the present and help meet the challenges. The current study predicts that this interest in science subjects and teachers will help to progress to the future in a manner that achieves the objectives and is in line with the policy of Oman in Achieving the Oman Vision Project 2040, As indicated at the Oman Forum 2017. Indeed, there is an increased requirement for cooperation and efforts in all areas, especially the aspect of education and science education, particularly the teaching of physics as the basis for most theoretical and applied sciences. The current study is an attempt to model the relationship between the understanding of the nature of physics, the pedagogical content knowledge, Achievement motivation, and students' preference of physics in Oman.

1.4 Problem Statement

The Sultanate of Oman's government has been planning to develop the education system to keep up with the demands of the 21st century. The “Fourth Industrial Revolution” or 4IR considered mathematics and science, especially physics, as the essential requirements to fit the trend. Generally, education development in the Sultanate of Oman began with applying basic education in the academic year of 1998/1999. Basically, basic education consists of two stages: the first includes grades

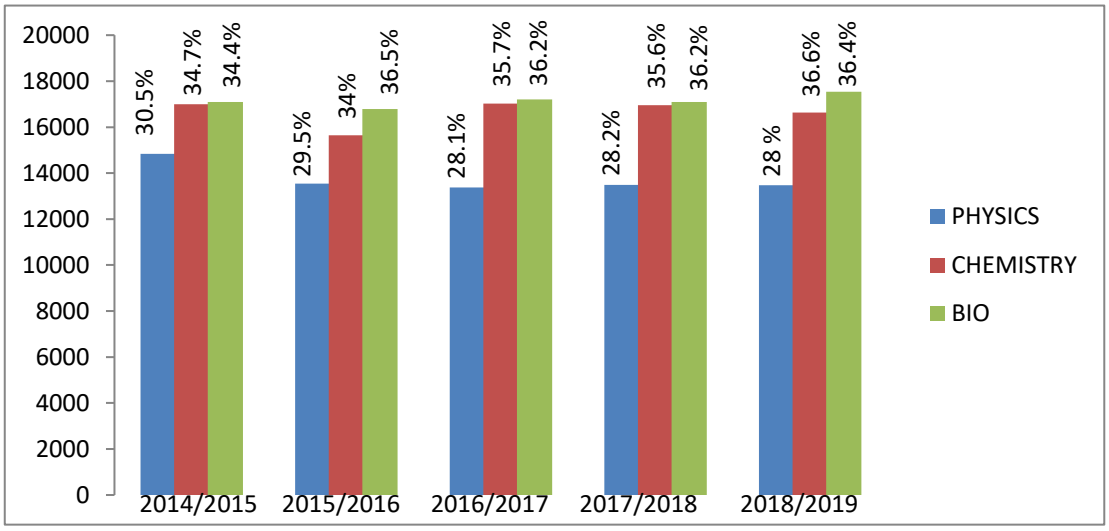
one to fourth grade, and the second involves classes sixth to 10th grade. The 10th grade is the end of the basic education level. Then, students will start to study at another level of education, namely "post-basic education." Altogether, 10th grade is the most essential stages of basic education because students will choose their study path for post-basic education by choosing among different science subjects: physics, chemistry, and biology. Based on the researcher's observation, and educational evaluation indicators, there is a decline in students choosing physics to study within science subjects in 11th grade.

According to education statistics in the Gulf Cooperation Council Countries (GCC), there is a widespread concern in the GCC countries in general due to the reluctance of students to choose physics to study (GCC-STAT, 2017). Thus, the interest in science education is of importance as these countries are seeking an advanced scientific and technological future in all branches of science in their current plans to keep pace with the Fourth Industrial Revolution (4IR). The researcher has noted this in his experience in the field of physics education and by reviewing the literature. For instance, in the United Arab Emirates (UAE), the statistics published in Al Bayan (2012) indicate a decrease of 31.1% in the number of students in the science section who registered for scientific subjects. Indeed, the current study considered the reluctance of students to choose scientific subjects in general and physics in particular as an essential matter that calls for attention and interest in science education. Statistically, the reason for students' reluctance to study physics is due to the difficulty in understanding the physics contents, and the students consider physics to be distant from the student's real life (Balfqih, 2010, & Nora et al., 2012). Here, the present study concludes that there may be other different reasons leading to this reluctance to study

physics, such as the nature of the teaching of physics, the inappropriate strategies used by the physics teacher during the teaching of physics subject as confirmed by the study of Mohammed (2015), which was led to form negative trends students have towards physics, and it affected their preferences to study physics. Via Omani Education Blueprint 2000-2020, the Oman education system has highlighted the needs to meet the quality of high international standards. The government attempts to reinforce the system by promoting education that focuses on various core skills. The most important of those skills is focus for scientific education to help generations to face current and future challenges especially in science and technology (Directorate General of Education, 2019). In that line, the Omani education system was interested more in teaching scientific subjects. Statistically, the results of the assessment of the 10th-grade student review among science subjects during the academic years 2014/2015 to 2018/2019 indicated a decreasing trend in the number of students choosing physics compared to other science subjects (Ministry of Education, 2019). Department of Statistics graphically shows a comparison between the numbers of the students who chose the science subjects in the academic years from 2014 to 2019, as in Figure 1.3.

Figure 1.3

Students' choices between science subjects for academic years 2014 to 2019



Physics is a core subject of STEM-related fields and a core requirement for future life (Kennedy, & Odell, 2014). Generally, several factors make us interested in teaching physics, such as the fact that physics plays an essential role in most scientific and practical fields. Moreover, it is one of the core areas in technical development and other theoretical sciences such as chemistry, geology, mathematics, astronomy, biology, and applied science, including medicine, engineering, and agriculture. In fact, almost everything around us can be described accurately by the laws of physics. Therefore, we need to pay attention to physics education and elements and variables that can help to develop it, such as the PCK. Generally, the science teacher is the main factor in the educational process even with the best curricula, books, activities, and educational programs, and the objectives of the educational process are not achieved unless the teacher is highly competent, capable of directing students' to learning of science, science teacher has good knowledge about PCK (Mohammed, 2015).

Generally, promoting scientific knowledge among students is one of the main goals of science education, as referred to by the National Research Council NRC (1996). Therefore, teachers of science must have some ideas and directions that may help them influence their student's acceptance and interest in studying science subjects, especially physics (Salih, Mai, & Shibli, 2016; Vilaythong, 2011). From an education perspective, the teacher is considered a person who is educationally qualified if he understands his specialization. For instance, to understand the nature of physics (NOP), a physics teacher should have the ability to teach and impart knowledge with all competence. In addition, they must have excellent communication skills and efficiently exercise their educational jobs and scientific roles. Physics teachers have to be capable of self-skills in communication and exercise their educational jobs and scientific roles with all efficiency. Moreover, teachers are also responsible for the effort to know the educational requirements, provide scientific knowledge, and reach the way that makes their teaching practices successful in serving educational goals (Zayton, 2014). Along the same line, the Association of American Physics Teachers has confirmed that physics teachers must have a foundation in Pedagogical Content Knowledge (PCK) (AAPT, 2002).

In addition, some previous studies such as Al Janabi (2016), Buabeng, Conner, & Winter (2015), PhysTEC (2014), Mohammed (2013), Belgon (2011), Al-zobi (2009), Ornek, Robinson, & Haugan (2008), Koponen, Mantyla, & Lavonen (2004), and Reif (1995), indicated that students face difficulty in understanding physics for some reasons. Among them is the low level of mental development and common misconceptions among students, which basically depend on the teacher’s approach to education and focus on scientific laws and mathematical treatments without interest in

conceptual treatments. This may be due to the teacher not understanding the nature of the subject he is teaching or lacking enough knowledge of PCK (Von Korff et al., 2016). Overall, this leads to students' reluctance to choose the subject of physics, even at the tertiary education level. The observation was confirmed by previous studies related to the lack of understanding of the teacher to PCK (Karısan, Senay, & Ubuz (2013), Etkina (2010), and the study of Angel, Ryder, & Scott (2005)).

Some studies dealt with the nature of science for science teachers during the service, such as the study of Al-Tamimi, & Rawaqa (2017), which aimed to study the nature of science among the teachers of the science of the upper stage and its relation to the level of understanding of controversial scientific issues in Jordan. The results showed that the level of understanding of the nature of science among teachers was average. Similar results were found in the study of Janabi (2016), which aimed to know the level of understanding of the nature of physics among physics teachers in Iraq and similar study by Mohammed (2013) was done in Palestine. Moreover, the study of Alswelmyeen & Al Olimmat (2013), sought to reveal the level of understanding of physics teachers of the nature of science in Jordan. Al-Shuaili (2008), aims to detect the level of understanding of chemistry teachers of the nature of science in the Sultanate of Oman and the results indicated that the level of understanding of science teachers of the nature of science is not at an acceptable level. Furthermore, Al-Hajri (2006) aims to determine the level of understanding of the nature of science for the teacher of science in fifth to 10th grade in basic education along with its relation to their practices in the classrooms. The result showed the performance of science teachers was significantly lower than the accepted rate of 80%. In a study conducted by Al-Hadabi (2000) to identify the level of understanding of the nature of science among students of

science teachers at Sana'a University, results showed a low level of understanding of the nature of science at the sample level of 48.8%, which is less than the acceptable level educationally 50%.

In the Sultanate of Oman, the results of many local and international evaluation studies of the reality of science education revealed the existence of some problems threatening the achievement of objectives. The most important of the results is the reluctance of students to study physics to a greater degree than their reluctance to study other branches of science (Ministry of Education, 2008). In the same context, the results of Trends in International Mathematics and Science Study TIMSS in the academic years 2011 and 2015 indicate the existence of a lack of understanding of physics among students, as indicated by the report TIMSS, 2015 (Ministry of Education, 2015). Students in Oman were ranked 41st in the academic year 2011 and ranked 37th in 2015 out of 48 countries participating in the international study (Al-Shabiba, 2016). Altogether, the report of TIMSS, 2011 and 2015 explained that the reason for the low achievement in science is the weakness of students' skills in physics knowledge and in understanding the physics concepts and nature of physics and their attitudes towards physics (Almazidi, 2017). On the other hand, the results of the seventh session of the International Study TIMSS 2019 indicate that students of the Sultanate of Oman were able to achieve the international average (500 points) and higher in science. However, the performance of the students of the Sultanate of Oman increased slightly compared to the results of the sixth session of TIMSS 2015. Overall, the proportion of students below the low level fell from 55% in 2011 to 39% in 2015 and then 37% in 2019 (Ministry of Education, 2021)

To further confirm the existence of this problem, the researcher conducted a pilot study on a sample of 50 random teachers of physics from both genders in the Sultanate of Oman. The results indicated that physics teachers lack an understanding of the nature of physics. Examples of the questions were: What is the difference between theory and physical law? 74.3% of the physics teachers concluded that the theory is a set of facts reached by conducting scientific experiments and that it is a set of hypotheses and conclusions. However, the law is observations formulated in a physical law. It is also noted that teachers have not been able to clearly distinguish between law and theory both in terms of definition and how to reach them. As to the question of what the most appropriate strategies for teaching physics are and why, most of the answers focused on the use of traditional methods, especially the method of lecture 85.71%. Most of the answers indicate the content and, through the lecture method, can transfer knowledge to students and teach them the scientific subject faster. This indicates that physics teachers lack an understanding of the nature of physics. As for the question: Were training programs conducted during the service related to the nature of physics and PCK? The teachers' responses were 100% that they had not received any training on the nature of physics and Pedagogical Content Knowledge since college, and most of the training courses they received were about teaching methods (Alsaadi, 2017).

Additionally, according to the Ministry of Education (2017), the level of students who chose to study physics in post-basic education was close to the results of their peers who chose other science subjects, such as chemistry and biology, despite their previous concerns about choosing physics. According to the educational literature, there are a lot of studies and research that seek to find out and measure the extent of

science teachers' understanding of the nature of science in science subjects in general and its relationship to several variables at different stages. This included studies conducted on science teachers before service, such as a study by Alswelmyeen & Rashed (2013) aimed to reveal the level of physics teachers' understanding of the nature of physics and their relation to teaching experience and their scientific qualifications in Jordan, and Al-zobi, Al-Sharaa, and Salamat (2012) aim to know the beliefs of the students on the epidemiological science in the Faculty of Educational Sciences at the Universities of Jordan and Hussein bin Talal. The study of Buffler, Lubben, and Ibrahim (2009) aimed to reveal the views of first-level students in physics specialization in nature, and the study of John & Brain (2002), aimed at assessing the nature of science at the pre-service science teacher in the UK. In contrast, in Oman, based on the research on the Omani databases (i.e., SQU & OMERN), there are no specialized studies in the Sultanate of Oman reveal the relationship between the understanding of science teachers to the Nature of Physics (NOP), Pedagogical Content Knowledge (PCK), Achievement motivation, and students' preference of physics (SPP). Therefore, this study aimed to develop the relationship model between the understanding of the nature of physics, the pedagogical content knowledge, and the student's preference for physics in Oman.

On the other hand, the problem with the study also comes from the researcher's observation through his work as a resident supervisor, which indicates a decrease in the motivation of some teachers, which shows some indifference, shortcomings, evasion of work and verbal phrases, the more of complaints and complaint of teachers about the high burden, as well as the frequent absenteeism or thinking of retiring and leaving the service. The study explained this by the low motivation of teachers' achievement. Since

teachers are among the most essential occupational groups in any society, Attention to this important group of workers in society's most important sector, education, is therefore significant.

1.5 Purpose of The Study

The current study assesses the opportunity to improve the trend toward physics learning via the development of the relationship model between the understanding of the nature of physics, the pedagogical content knowledge, and students' preference of physics. These assessments and development conducted via a learning environment are relevant to the government policy on science education development plans. Educationally, in the Sultanate of Oman's education system, the development of scientific knowledge content is the main priority (Ministry of Education, 2019). However, in the same context, scientific knowledge is needed more than theoretical knowledge for a student to face complex real life. Altogether, this situation forces the system to emphasize developing the positive trends of students in physics preference and their attitude toward physics study while preparing them with adequate knowledge in facing life's current and future challenges.

Via the Oman education blueprint for 2000-2020, the Oman education system has highlighted the need to meet high-quality international standards. Therefore, the government attempts to reinforce the system by promoting education focusing on various core skills. The most important of those skills is the focus on scientific education to help generations face current and future challenges, especially in science

and technology (Directorate General of Education, 2019). Furthermore, in line with Oman's new vision for 2020-2040, it has become more necessary to pay more attention to the field of science in general and physics in particular due to the existence of general objectives for the Sultanate to position itself among the advanced countries in the field of science and innovation. This can only come by paying particular attention to the field of science education and physics. To overcome this challenge, educators and those interested in education must work on continuous training of teachers in science in general and physics teachers in particular. They must be continuously prepared and trained to develop their understanding of the nature of physics and its educational, scientific content, which may modify teachers' views of their students' preference toward physics, which will reflect positively on students' trends toward a preference for physics.

The current study attempts to develop the relationship model between the understanding of the nature of physics, the pedagogical content knowledge, and students' physics preferences in the Sultanate of Oman. The study also examines if achievement motivation (Am) mediates the relationship between Independent Variables (understanding of the nature of physics (NOP), pedagogical content knowledge (PCK)), and students' preference of physics (SPP). In addition, the current study also examines the moderating effect of specialization, teaching experience, and gender on the relationship between the nature of physics and pedagogical content knowledge, students' preference of physics of the science teachers for the 10th grade in the Sultanate of Oman.

1.6 Research Questions and Corresponding Hypotheses

This study is designed to seek answers of the outlined research questions. To achieve the previously mentioned objectives, the study needs to address the following research questions and test their corresponding hypotheses, as tabulated in Table 1.2.

Table 1.2

The summary of research questions and the main hypotheses

Research Question 1: Is there a significant relationship between (the pedagogical content knowledge and the understanding of the nature of physics) and the students' preference of physics?
Main Hypothesis 1: causal effect
H1: Pedagogical content knowledge has a significant effect on students' preference of physics. H2: The understanding of the nature of physics has a significant effect on the students' preference of physics.
Research Question 2: Does achievement motivation mediate the relationship between (the pedagogical content knowledge and the understanding of the nature of physics) and students' preference of physics?
Main Hypothesis 2: mediates effect
H3: Achievement motivation mediates the relationship between the pedagogical content knowledge and students' preference of physics. H4: Achievement motivation mediates the relationship between the understanding of the nature of physics and students' preference of physics.
Research Question 3: Does gender, specialization, and teaching experience moderate the relationship between the pedagogical content knowledge and students' preference of physics?
Main Hypothesis 3: moderation effect
H5: Gender moderates the relationship between the pedagogical content knowledge and students' preference of physics. H6: Specialization moderates the relationship between the pedagogical content knowledge and students' preference of physics.

H7: Teaching experience moderates the relationship between the pedagogical content knowledge and students' preference of physics.

Research Question 4: Does gender, specialization and teaching experience moderate the relationship between the understanding of nature of physics and students' preference of physics?

Main Hypothesis 4: Moderation effect

H8: Gender moderates the relationship between the understanding of the nature of physics and students' preference of physics.

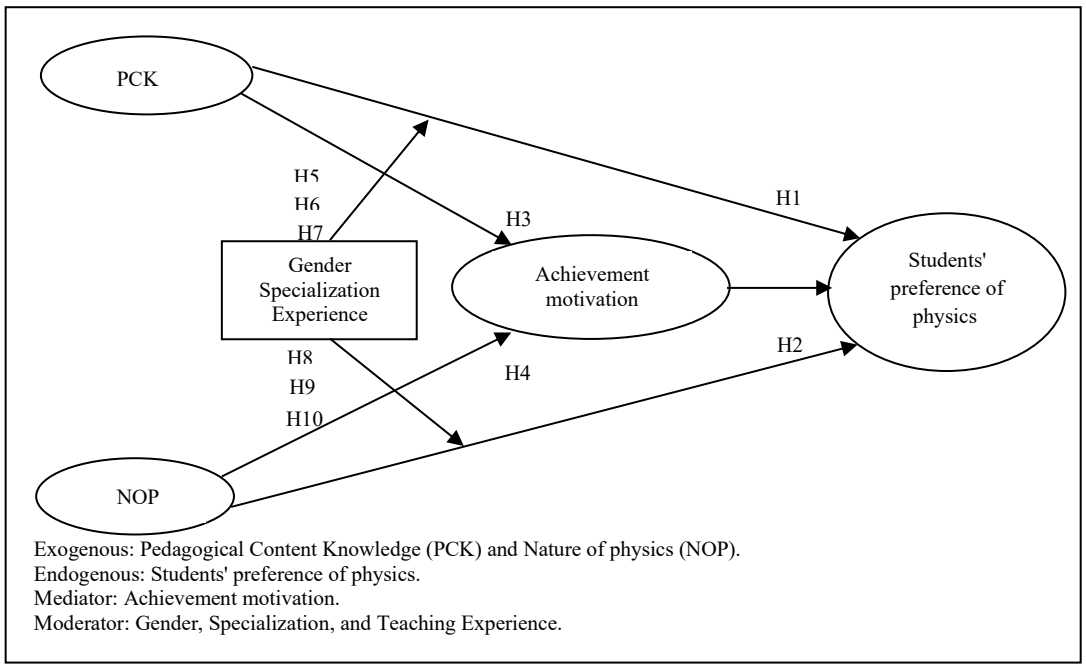
H9: Specialization moderates the relationship between the understanding of the nature of physics and students' preference of physics.

H10: Teaching experience moderates the relationship between the understanding of the nature of physics and students' preference of physics.

Figure 1.4 illustrates the main hypothesis among constructs in this study.

Figure 1.4

The Main Hypotheses among Constructs in the Study



Exogenous: Pedagogical Content Knowledge (PCK) and Nature of physics (NOP).
Endogenous: Students' preference of physics.
Mediator: Achievement motivation.
Moderator: Gender, Specialization, and Teaching Experience.

1.7 Objectives of The Study

The general objective of this study is to identify the significance of the nature of physics (NOP), Pedagogical Content Knowledge (PCK), Achievement motivation and Students' preference of physics from the view of the science teachers. Additionally, this study intends to study the moderating effects of possible variables on the construction, which may develop teachers' views of students' Preference of Physics. The study is designed to achieve the following main objectives:

1. To determine the relationship between the pedagogical content knowledge (PCK), the understanding of the nature of physics (NOP) and the students' preference of physics (SPP).
2. To examine the mediating effect of achievement motivation (Am) on the relationship between the pedagogical content knowledge (PCK), the understanding of the nature of physics (NOP) and students' preference of physics (SPP).
3. To examine the moderating effect of gender, specialization, and teaching experience on the relationship between the pedagogical content knowledge (PCK) and the students' preference of physics (SPP).
4. To examine the moderating effect of gender, specialization, and teaching experience on the relationship between the understanding of the nature of physics (NOP) and students' preference of physics (SPP).
5. To identify the level of NOP, PCK, Am, and SPP among science teachers.

1.8 Significance of the Study

The importance of this study is vital in that it builds a model based on understanding the nature of physics and knowledge of pedagogical content, which helps science teachers teach physics subjects and increase their achievement motivation in a way that enhances their perception of students' preference for physics. Generally, no society can keep abreast of industrial, medical, and agricultural technological developments without its members having a clear understanding of science and its methods. The importance of this study is also to understand NOP and PCK with essential and influential variables in the educational process, namely SPP and Am. In addition, this study can help those who prepare physics teachers at the tertiary level to train them professionally and improve their understanding of the nature of physics. Also, it can encourage them to find a way to pursue the development of physics science for physics teachers before and during service. The importance of this study is also evident in that it benefits curriculum developers, programs, and educational activities in supporting different teaching methods that help the physics teacher increase their achievement motivation to present the physics subjects in a way that assists them to develop their view about of the students' preference of physics. This study helps physics supervisors prepare appropriate training and development programs for physics teachers to enhance their understanding of the nature of physics science and the teaching strategies they use to teach physics. The study can also benefit physics teachers in building a scientific culture in students based on a proper understanding of physics science's objectives, nature, and methods.

This study also gives an essential and valuable contribution to knowledge in the field of education in general and teaching physics in particular. Firstly, this study deals with an important field in science education from the point of view of constructivism philosophy in the field of the nature of science. The nature of science is one of the most critical contemporary issues that emerged with scientific development and the fourth industrial revolution. Secondly, understanding the nature of physics has become a fundamental goal sought by all members of society and its institutions. Historically, a society can only keep up with technological, industrial, medical, and agricultural developments with its members having a clear understanding of science and its methods. Therefore, this study's importance is in understanding the nature of physics, pedagogical content knowledge, and students' preference of physics. Thirdly, the teacher's Pedagogical Content Knowledge (PCK) and all the related elements for curriculum and learners and their characteristics and teaching strategies are essential things that this study seeks to discuss with science teachers in the 10th grade in the Sultanate of Oman. Fourthly, this study will benefit teachers and interested individuals in directing students to choose science subjects in the 10th grade in the Sultanate of Oman. Fifthly, this study can also help supervisors prepare the physics teachers in colleges and universities to prepare and develop them professionally, improve their NOP and PCK, and encourage science teachers to increase their motivation for achievement.

Furthermore, this study may help science teachers follow the nature of physics and PCK before practical service and during service. Sixthly, this study is in line with the Omani government education plan, which is with the implementation of Omani Vision 2040 that focuses on preparing a scientifically educated generation capable of

dealing with the 4IR by increasing interest in scientific subjects, especially physics. Furthermore, since applying the basic education system in 1998/1999, science teachers can directly influence students to choose the scientific subjects they will study in post-basic education, which may depend on the teacher's specialization and understanding of the nature of the subject. Finally, others may benefit from this study, including decision-makers and authors of curricula, programs, and educational activities in support of and inclusion of different teaching methods; this would develop positive attitudes and students' preference of physics in Oman.

All in all, this study can help physics supervisors prepare appropriate training and development programs for physics teachers to improve their understanding of the nature of physics and the teaching strategies they use in teaching physics. In addition, the study can benefit physics teachers in developing scientific culture and their students' preference for physics based on a correct understanding of the objectives of PCK and NOP. Fortunately, the researcher's review of educational literature did not find studies that tested the current study variables, which include understanding the nature of physics science, pedagogical content knowledge of science teachers' achievement motivation as moderators, and as a mediator, gender of the teacher as a modified variable, and students' preference for physics through the perspective of teachers. Therefore, the researcher expects this study to be meaningful and a scientific addition to educational literature, especially concerning physics education.

1.9 Limitations on Study

Identical to previous studies, this study was also associated with several limitations in scope and methodology. First, this study was applied to 10th grade science teachers in the Sultanate of Oman. Consequently, the result may only be generalized to the study population above. In other words, the results may be different if the scope is expanded to include more classrooms and school levels because other classes in the different levels of study have different characteristics from those of the 10th grade and education levels, whether at the characteristics of students or the nature of the curriculum or the education levels. Using this method, those interested in physics teaching at the Ministry of Education can observe how the achievement motivation of teachers plays a role in students' preference for physics.

1.10 Operational Definitions

In this study, the researcher used several basic terms with distinct operational definitions. The following are definitions of the principal terms used in this study which clarify the search terms based on previous research.

- *Nature of Physics (NOP):* The essence of physics includes the objectives and characteristics of physics, science processes and ethics, and interaction with physics, technology, and the community (Mohammed, 2015). It will be expressed by the degree the science teacher obtains in physics specialization by answering

a questionnaire. The Dimensions used by Al Janabi (2016) and Mohammed (2015) in their studies will be adapted for this study.

●*Pedagogical Content Knowledge (PCK):* A set of rules that contribute to the empowerment of teachers and enhance their perception of the educational process, including all elements of the educational process, such as students, content, teaching methods, teaching methods, and evaluation (Hallala, 2018), in this study included Knowledge of the Goals of Teaching Physics, Knowledge of the Physics Curriculum, Knowledge of the Learner's Characteristics, and Knowledge of Context (Whitt, & Abigail, 2016:13). It will be expressed by the degree that the science teacher will obtain in the specialization of physics by answering a questionnaire. The Dimensions used by Al-Ramahi & Rawagah (2018); (Von Korff et al., 2016), and Siyam (2014) in their studies will be adapted to the purposes of this study.

- *Students' Preference of Physics (SPP):* A set of responses of the individual emotionally accepting or refusing physics and its applications to life (Almazidi, 2017). The statements in the questionnaire adapted from several studies, such as Almazidi (2017) and Ibrahim & Saleh (2009) in their studies will be adapted to the purposes of this study.
- *Achievement motivation (Am):* the extent to which an individual is prepared to achieve his personal and cognitive goals to accomplish the work assigned to him in his field of specialization (Al-Dafry, 2021). And Al-Adwan and Al-Rababaah (2018) defined achievement motivation as: Strive for success and accomplish tasks at a high level and efficiency.
- *Specialization:* The main specialization of a science teacher (physics, chemistry, and biology) (Mebley, 2010).

- *Experience:* is performance knowledge gained through practice, and teaching experience indicates how many actual years the teacher has spent teaching (Baker, 2020).

Other Operational Definitions related to the study:

- *Basic education:* A unified education supplied by the state to all students at school age (6-15) year. The period of study in basic education is ten years. It is based on providing the basic educational needs of information, knowledge, skills, values, and trends that enable students to continue learning and training according to their preferences, aptitudes, and abilities. This type of education is developed to meet the challenges and circumstances of the present and the outlook for the future within the framework of comprehensive community development (Ministry of Education, 2011).

1.11 Theoretical Framework and Conceptual Framework

Based on one of the essential aims of physics teaching is to provide the learner's knowledge and scientific culture and link him to the world in which he lives and to the realities of its environment, and his daily life and interests for feel the value of what he learns that leads to increases his motivation and its tendencies, scientific trends and preferences grow. In this context, the Federal Commission responsible for the Development of Science Education in the United States of America has considered that one of the essential aims of teaching science is the preparation of a scientifically

educated citizen (Ghassan, 2020). On the other hand, the current study emphasizes that the aims of education must include changing the learner's cognitive path through knowledge and information provided to him, which is known as an individual's cognitive preference, and which usually guides the learner towards accepting or rejecting the content of a subject. In addition, pedagogical studies emphasized the importance of identifying the methods and patterns to be practiced by the teacher in education in order to teach the learner and provide him with scientific information, knowledge, and scientific facts. Previous studies considered this an indicator that helps identify the characteristics of the learners and also helps the teacher know the trends of the learners towards the preference or rejection of studying a particular subject (Abdulsalam, 2000).

Majeed (2001) emphasized that a learner's preference has an important impact on the study of different subjects, which leads to the development of his knowledge environment. Also, Majeed's (2001) study considered that preference is an indicator of the teaching method and educational attitude created by the teacher in the classroom that helped to organize the appropriate educational process. Therefore, the current study indicates that the study of preferences and attention to them has become an urgent need to help the learner accept the study of different subjects of study. The present study confirms that this depends on the teacher's understanding of the nature of his subject and his pedagogical content knowledge of the subject, as well as the knowledge of the strategies and teaching methods appropriate for each educational situation and the teacher's knowledge of the psychological characteristics of learners, in turn, helps to promote and encourage learners to prefer to study the content of the subject. Majeed

study (2001) also referred to a teacher's motivation, which also helps to promote the preference of learners towards studying the subject.

According to the review of the literature, the theoretical framework and conceptual framework have been developed to represent the relationships between the understanding of the nature of physics (NOP), pedagogical content knowledge (PCK) and the model of students' preference of physics (SPP). The proposed model was adapted from several models namely the model of Pedagogical Content Knowledge-guided Lesson Study in chemistry PCKLS (Lucenario et al., 2016), the model of the pre-service teachers, digital nativity TPACK, and the model of Shulman (1987), and the nature of physics from the nature of science NOS based on constructivist learning theory (Murphy, 1997). In short, previous research showed that teachers have a set of beliefs about the nature of science, how students learn, and teaching strategies that have been shaped by a long history of learning experiences in education (Thomas & Pedersen, 2001). This traditional view of the nature of science as a way of finding truth-finding facts, still known as the Transmission Model, has been formed in the teaching of science (Al-Muhtasib, 2005). According to this model, the teacher presents the facts, concepts, and generalizations directly. Then, the students are assigned to apply some of them in practical situations, solve some issues, and work separately on similar activities to confirm the learning process. This model assumes that learning occurs in the quietest classroom (Windschitl, 1999). They indicated that science education needs to be reformed and developed around the value of learning by work and inquiry education (NRC, 2012). Behavioral theory is still widely used in the educational process, although it still needs to develop the nature of science (Mumni & Ali, 2010). To sum up, this led

educators and those interested in the field of education to move from the Transmission Model to the constructivism model of education (Muller, 2008).

According to studies based on constructional theory, constructivism influences teaching in science and mathematics. It has significantly impacted the development of science curricula, teaching methods, and programs to prepare teachers. Although construction began as a learning method, it expanded and became a theory in education and scientific knowledge, as confirmed by the study (Matthews, 2000). According to the literature review, the principal founder of constructivist theory is Jean Piaget, who considered knowledge to be based on building or reconstructing the subject of knowledge. In short, the constructivist theory is based on the individual building his knowledge through his interaction and his adaptation to the environment right up to the occurrence of cognitive balance. According to Jean Piaget's theory, the balance occurs when the individual acquires a specific experience and adapts it to his previous cognitive structure, which leads to imbalance changes. Then, the subsequent balance develops intellectual structures that merge with previous intellectual constructs, resulting in the construction of new, more sophisticated knowledge (Al-Atwi, 2007). In educational terms, the structural theory is an educational philosophy concerned with the active role of the learner in building his knowledge through his previous experiences and social negotiation with his colleagues in the presence of a teacher helping the learner to build his knowledge through activities and experiences and experiences directly and indirectly. The International Dictionary of Education defines that as "a vision in the theory of learning and child development based on the child being active in building his thinking patterns as a result of interacting his innate abilities with experience" (Zayton, 2013, p. 17). It was also defined as "an educational theory that

focuses on the direct impact of knowledge-building experiences, where it is assumed that learners build their mental models by interacting with their environments (Weeks, 2013). Learning in the constructivist perspective means the adaptations occurring in the functional cognitive systems of the individual, which occur to offset the contradictions resulting from his interaction with the empirical world data (Almazidi, 2017; Attieh, 2015). All in all, this study will depend on the constructivist theory, which focuses on the idea that knowledge is constructed to meet the needs of the person and is based on Piaget's theories of cognitive development (Bodner, Klobuchar, & Geelan, 2001). The theory assumes that the conscious person builds his knowledge based on his own experience and does not receive it negatively from others as if he is already transmitting information ready for use (Phillips, 1995), where the person builds his knowledge by reason and experience. All in all, this means that knowledge is related to the learner's experience, practice, and activity in dealing with the components of the world around him, including sense, perception, attention, remembering, judgment, reasoning, and others (Alsaadi, 2015).

Therefore, this study is a confirmation to the physics teacher to develop his knowledge for helping students to build their knowledge through scientific strategies and practices that allow them to build their knowledge from their previous experiences and not transfer it through traditional methods such as indoctrination and conservation. As well as many studies indicate that there is an effect between structural theory and physics research, and the most famous study which illustrates that is Churukian (2002). Churukian (2002) explained the impact of constructivism on physics education research; through the past thirty years, physicists have been researching how students learn physics. The students come into the physics classroom with pre-formed ideas

about how the world around them works. These ideas are based on their life experiences and are often referred to as common sense beliefs (Halloun & Hestenes, 1985) or preconceptions (Redish, 1994). Students use this background information to interpret what they are learning in the physics classroom, which is the principle of constructivism theory. As the present study seeks to achieve some of the characteristics of constructivism theory pointed out in (Alsaadi, 2015; Poland, 2003 & Murphy, 1997):

i. It makes the learner the focus of the educational process.
ii. Allows the learner to represent the role of a scientist; its lead develops a positive trend towards science and scientists, the community, and various issues and problems.
iii. It allows the learner to practice essential and integrated science processes.
iv. It allows the learner the opportunity to discuss and dialogue with his or her fellow learners or the teacher, thus helping to grow the language of his or her dialogue and make him or her active.
v. Links the model of constructive learning between science and technology, allowing learners to see the importance of science to society and the role of science in solving society's problems.
vi. It allows learners to think about as many solutions as possible to a single problem; it encourages creative thinking and increases motivation for students to learn.

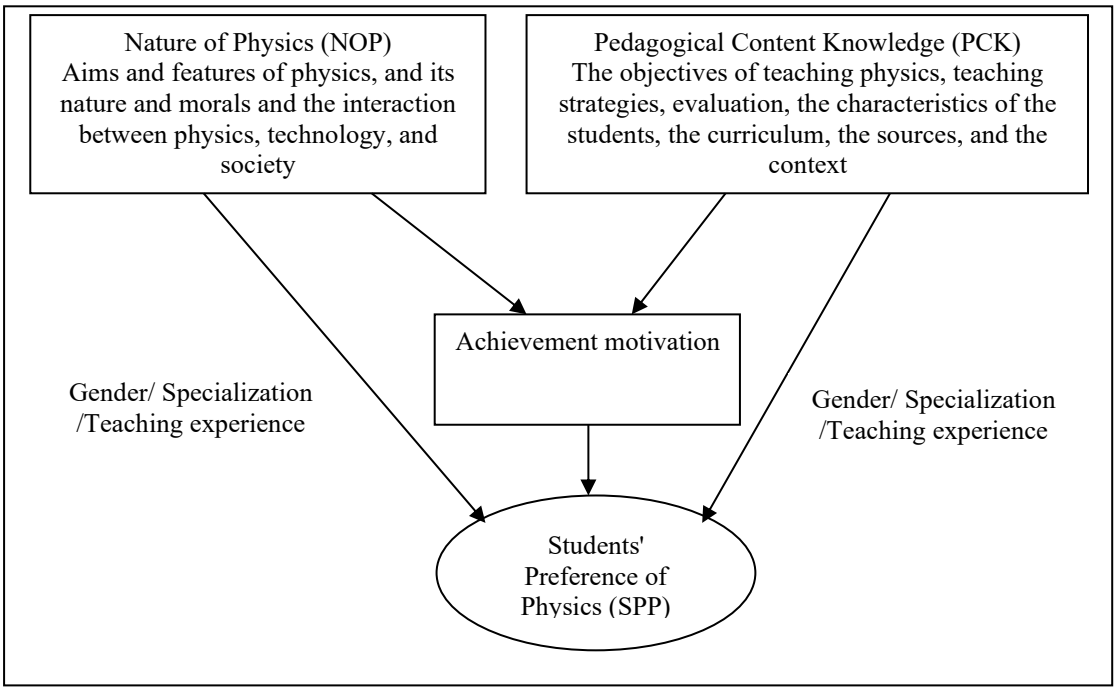
In this study, the researcher used the survey method for collecting the data, which can be described as a structured way to collect information from the respondents' science teachers in the 10^{th} grade. In addition, the study instrument was adopted through

a literature review related to this study and its variables, which was, in final a single instrument that included the understanding of the nature of physics, pedagogical content knowledge, students' preference of physics from the point of view of teachers, and achievement motivation for teachers. The researcher chose this methodology to conduct this study because it has several advantages, such as it focuses on studying the phenomenon as it is, in fact, without the researcher's intervention in controlling their variables. Also, it helps to search for the reasons, facts, and relationships related to the problem of study in broader and more profound. Moreover, this methodology has been adopted in most of the previous studies similar to this study (Lucenario et al., 2016; Alhosenih, 2016; Al Janabi, 2016; Fraenkel, Wallen, & Hyun, 2012; Van, Verloop, & De Vos; 1998).

All the instruments were presented to specialized experts to verify their validity. Their reliability was calculated using appropriate scientific methods. Statistically, the researcher used suitable statistical methods to analyze the results and make suitable recommendations for the study. This study is distinguished from other previous studies in several things, the most important of which is that it combines the variables of the (NOP), (PCK), and (SPP). The researcher did not find any similar Arab or foreign study combining these variables. On the other hand, this study also deals with different statistical methods not covered by previous studies that dealt with some of its variables. In this study, the researcher used Structural Equation Modeling (SEM). In contrast, the previous studies adopted the SPSS program and calculated mathematical averages using simple mathematical methods. Figure 1.5 shows the relationship between the study's variables (The Conceptual Framework).

Figure 1.5

The Conceptual Framework



Historically, experiences in the field of the nature of science and knowledge of pedagogical content among teachers have shown that it must include the teacher's knowledge of the nature of science for the subject he teaches to students and his knowledge of pedagogical content on the specialization taught by the teacher, goals, goals, and characteristics of students, teaching a specific subject, curriculum, learning sources and context as indicated (Heshwah, 2005). The findings of Mistadde s (2007) indicated that physics teachers' understanding of the nature of physics and their pedagogical content knowledge could be developed and that physics teachers' tendencies towards teaching new subjects in physics were positive. The "Khalifat" experiment (2011) aimed to reveal the trends of physics teachers towards evaluation strategies in science curricula as one dimension of pedagogical content knowledge (PCK), its impact on gender, scientific qualification, and teaching experience. The experiment results showed that the level of physics teachers' trends toward teaching

strategies and their knowledge of pedagogical content was moderate. Furthermore, there were no significant differences attributable to the sex variable and scientific qualification, while there were significant differences for the teaching experience variable in favor of the category (5-15 years).

Given the reality of teaching science in general and physics in particular, there is a discrepancy between science teachers in general and physics teachers in particular in their knowledge of PCK, as there are several studies, models, and experiments dealing with NOP and some variables such as years of experience, gender, and specialization where: The results of the Alswelmyeen & Al Olimmat study (2013) indicated that the level of understanding of the nature of science among physics teachers was average, as well as the existence of function differences attributable to gender variables. The model Awadah and Al-Saadni (2007) determines the relationship between the teacher's knowledge of the nature of science and his relationship to his teaching practices. The model found a strong correlation between understanding the nature of science and the teaching practices of the science teacher within the classroom. In addition, the study of (Yao Liu, & Lederman, 2007) aimed to determine the relationship between knowledge of the nature of science and teaching. Its findings showed a link between teachers' beliefs and concepts of the nature of science and recommended that subjects of the nature of science should be included in the curriculum.

Also, the Al-Shuaili study (2008) aimed at determining the level of understanding of the nature of science by chemistry teachers in the light of gender variables and teaching experience, and the results of the study found that the level of

teachers' understanding of the nature of science was (41%), there were no function differences attributable to gender variability and teaching experience. The study of Buabeng, Conner, & Winter (2015) confirmed that teachers' beliefs influence their teaching. The experience of Hashweh (1987) showed that teachers who teach subjects different from their main specialization are more likely to present the subjects with misconceptions to students than teachers who teach the subjects in their main specialization. The study of (Sanders, Borko, & Lockard, 1993) also confirmed that teachers who teach subjects not within their original specialization had limited knowledge of PCK and misconceptions in subjects they teach to students were more than teachers who teach in their specialization.

Van Driel also introduced; Verloop; & De Vos (1998) pilot study focused on PCK and its relationship to the nature of the subject offered by the teacher, and the experience concluded that sufficient knowledge of the subject provided by the teacher to students is a prerequisite. In addition, the experience also considered that the teacher's knowledge of PCK helps to enhance students' understanding and improve the teacher's perception of student preference and acceptance of the subject. Educationally, studies and experiences in the fields of nature of science and teacher knowledge of pedagogical content, beliefs, and motivation towards education as well as the impact of specialization and years of experience, were also mentioned. A study (Hallala, 2018) noted that the teacher's essential specialization differs from the subjects he teaches to students is one of the most important reasons for a gap and reluctance to study subjects. For example, the study noted a gap between teachers' theoretical knowledge of PCK and its actual application in teaching. In addition, the study found that many teachers who have spent most of their university years studying mathematics or chemistry, for

example, have had to teach physics or biology content; this has led to the teacher's lack of knowledge of pedagogical content very clear in teaching. Chan and Yung (2018) studied the impact of teaching experience and PCK on teachers teaching a new topic. The study's results indicated that teachers' previous experience helped develop their planning for teaching the new topic. The study's results (Dhoyb) 2018 also showed statistically significant differences between the teacher's knowledge of PCK and the years of experience in favor of more than ten years of experience. However, it pointed out that there are no significant statistical differences between the teacher's knowledge of PCK and the variable of gender and scientific qualification and specialization.

In addition to the above, the study by Asherfaat and Qataysh (2017) indicated that there are statistically significant differences in the motivation of achievement but indicated that there are no statistically significant differences in the level of motivation of achievement for teachers attributable to gender. By examining the implications of teacher motivation and innovation indicators towards professional growth and achievement, the Maya Angelou study (2013) reached several results: achievement and acceptance are essential internal catalytic factors leading to career and professional development. The study also showed that teachers with achievements are affected most by encouragement and motivation, that teachers have a desire to pursue permanent professional growth, and that there are no statistically significant differences in the motivation of achievement between experienced teachers and non-experienced teachers. Korur & Eryilmaz (2018) experiment aimed at detecting the impact of physics teacher characteristics on students' motivations in terms of achievement in attainment and readiness to study physics, and the results of this experiment showed that teachers' characteristics such as enthusiasm and giving examples of everyday life increased the

motivation of students, by increasing their interest and willingness to participate in the discussion within the classroom, It also showed students' tendency to generally oppose teacher behaviors or characteristics when teachers showed inappropriate behavior. Some studies have indicated a positive effect between PCK and self-esteem, which is confirmed by the Jaber study by Al-zobi (2018) on mathematics teachers. Al-Kalbani and Al-Adili (2020) noted that the characteristics of teachers of science, physics, and teaching methods could influence students' decisions and their reluctance. It also noted that the beliefs held by the teacher influence the teaching method followed in teaching and presenting them to the student. Al-Ma 'aoui, 2015, found an effect of PCK in NOS, which indicated that there were statistically significant differences in understanding the nature of science attributable to the benefit of the experimental group.

On the other hand, Ghneim, Abd, and Ayash (2016) noted that all teachers' beliefs about their roles and responsibilities and their relationship to the nature of their work and the nature of the material they teach result from the beliefs they possess and base their educational practices on it. So, the teacher must be interested in developing his pedagogical knowledge of content to help his students learn and build his pedagogical knowledge when teaching specific topics within their field. It can be said that the pedagogical knowledge of content includes all the knowledge a teacher must take into account during the teaching process, such as defining learning objectives, accurate understanding of content, identifying prior learning requirements and appropriate teaching strategies, taking into account students' characteristics and needs, and difficulties encountered.