Technological Pedagogical Content Knowledge of Prospective Teachers

Dissertation submitted to N.V.K.S.D. College of Education (Autonomous), affiliated to Tamil Nadu Teachers Education University, in partial fulfilment of the requirements for the award of the degree of

MASTER OF EDUCATION

by

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DECLARATION

I declare that the dissertation entitled Technological Pedagogical Content Knowledge of Prospective Teachers submitted by me for the degree of Master of Education is the result of original and independent work carried out by me during the academic year 2022-2024 under the guidance of Dr. Prasad P.S, Assistant Professor, N.V.K.S.D. College of Education, Attoor. This work is not submitted on the basis for the award of any degree, diploma, associateship, fellowship or any other university or institution.

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CERTIFICATE

This is to certify that the dissertation entitled Technological Pedagogical Content Knowledge of Prospective Teachers submitted for the degree of Master of Education by Prema Malathy F.G is an original record of research work carried out by her during the academic year 2022-2024 under my guidance and supervision. It is further certified that this work is original one free from any duplication. This work has not been submitted for the award of any degree, diploma, associateship or fellowship of any university or institution.

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PREMA MALATHY F.G

CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

TK	–	Technological Knowledge
PK	–	Pedagogical Knowledge
CK	–	Content Knowledge
PCK	–	Pedagogical Content Knowledge
TCK	–	Technological Content Knowledge
TPK	–	Technological Pedagogical Knowledge
TPACK	–	Technological Pedagogical Content Knowledge

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

1.1 NEED AND SIGNIFICANCE OF THE STUDY

1.2 STATEMENT OF THE PROBLEM

1.3 OPERATIONAL DEFINITION OF KEY TERMS

1.4 OBJECTIVES OF THE STUDY

1.5 HYPOTHESES OF THE STUDY

1.6 METHODOLOGY IN BRIEF

1.7 DELIMITATION OF THE STUDY

1.8 ORGANISATION OF THE REPORT

CHAPTER II

REVIEW OF RELATED LITERATURE

2.1 THEORETICAL OVERVIEW

2.2 STUDIES RELATED TO TPACK

2.3 CRITICAL REVIEW

CHAPTER - III

METHODOLOGY

3.1 METHOD ADOPTED FOR THE STUDY

3.2 POPULATION AND SAMPLE

3.3 TOOLS USED IN THE PRESENT STUDY

3.4 STATISTICAL TECHNIQUES USED FOR THE STUDY

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

CHAPTER – V

FINDINGS, IMPLICATIONS AND CONCLUSION

REFERENCES

APPENDICES

PUBLISHED ARTICLE

PUBLISHED ARTICLE

CHAPTER I

INTRODUCTION

Teaching is one of the noblest professions in the world. In recent years, tremendous changes have happened throughout the world in Education. Online education has had a profound impact on people all over the world, and as a result, students can now learn from anywhere. Teachers must be able to instruct in a variety of subjects and teach students with engaging lesson plans. The teacher should have the ability to assess their own teaching learning process. The teacher can motivate students to adopt and learn through modern techniques. Online tutoring platforms ensure students with a flexible and convenient way to receive support and guidance with their coursework (Dolenc et al., 2015). The National Education Policy (NEP) 2020 encompasses that teachers will require training with high quality content as well as pedagogy technological skills. The teacher can effectively teach through online learning platforms by using various tools. The use of technology in science education has become increasingly common in recent years. Interactive simulations and virtual experiments allow students to manipulate variables and observe the effects (Liou & Chang, 2018). During the covid-19 pandemic, the teaching learning process underwent a significant transformation. Educational institutions in India adapted new technologies, utilizing video conferencing platforms and learning management systems for virtual classroom. Online education has provided an ability to learn anywhere, at any time and has increased the educational productivity. Prospective teachers are responsible for shaping the minds and characters of future generations by inspiring, motivating, and guiding students to meet the needs and challenges of future life. Effective teaching is the cornerstone of quality Education. The evolution of technology across generations, from radio to Artificial Intelligence (AI) Technology can be a significant enabler of improvement on multiple dimensions of the education system. The role of motivated and capable teachers is crucial. However, technology, when used appropriately, can enhance teaching and learning experiences. NCF 2023 emphasize the importance of technology in education and guide how to integrate technology into teaching and learning. It could include using digital resources for teaching and learning and technology for assessments and evaluation. Teachers are equipped with the latest teaching methodologies, techniques and educational resources, which help them to create engaging and effective learning experiences for their students. National Curriculum Framework (NCFT) will be formulated by the National Council of Teacher Education (NCTE) in consultation with National Council of Educational Research and Training (NCERT), the pedagogy is expected to evolve to make education more experimental, holistic, integrated, inquiry- driven, discovery-oriented, learner-centred, flexible, and enjoyable (Rashi Sharma & Purabi Pattanayak, 2022). TPACK framework for the integration of technology and education to structure our classrooms to provide the best educational experience for students. The TPACK framework stands for technological pedagogical content knowledge. It is a theory that was developed to explain the set of knowledge that teachers need to teach their students a subject teaches effectively and use technology, tpac gives us three knowledge areas to consider technology.

1.1 Need and Significance of the Study

Technology plays an important role in teaching learning process in the present era. The innovation of technology in teaching science includes new resources for teaching-learning such as visual aids, projected aids, audio aids, audio visual aids, computer assisted learning, e-learning platforms, interactive video, power point presentation, lesson plans and online assessment tools. These are very helpful for the prospective teachers during practice teaching and their future profession. The teacher plays an important role in moulding the student's knowledge in subjects, their personality and is responsible for engaging learners with new technology for effective learning. The teachers can exchange and retrieve information from the various online sources. To enhance their subject knowledge, open educational resources can be used by teachers for teaching while students use them as supplementary materials for learning. Effective teachers are those who keep abreast of the latest information and can successfully impart it to their students. This involves looking up for any available resource material and keeping up with teaching methods. The teacher has to give more information than that are found in textbooks. Online search engine can fill this gap as it can provide access to different sources of information. It provides flexibility to learners in the digital world. Teacher education institutions give training to prospective teachers for effective pedagogy they have to adopt in the classroom. Roy and Roy (2015) found no direct trace of PCK in teacher education programmes though its reflections are there- In a study by analysing the NCTE regulations, 2014 curriculum. The student teacher may not have sufficient knowledge or training in using different audio-visual aids, information technology, multimedia, and the internet to enhance the learning experience of students. In order to provide effective teaching in physical science, teacher trainees need to browse the internet and stay updated with the latest information. Teacher should possess clear cut knowledge about TPACK for effective classroom transformation in this digital age. The smart board in classroom teaching has a greater potential to develop students' imagination and to improve their knowledge in Physics, Chemistry subjects. The teachers can use smart boards to create animations, simulations, and interactive diagrams that help students visualize complex concepts. Integrating technology with pedagogical content knowledge in Physical

Science helps the teachers understand better ways of presenting concepts, theories, facts, and principles through visual and auditory interactions during the learning process. This approach enables the students to improve the learning of scientific concepts and principles, which is essential for critical thinking, problem-solving, and scientific literacy.

1.2 Statement of the Problem

Teachers should possess sound pedagogical knowledge to create an engaging and productive learning environment that facilitates a meaningful learning experience. Incorporating technology into teaching learning process is inevitable. Prospective teachers are the future teachers to which extend prospective teachers have TPACK in the context of science education. Hence the problem is selected for the present study is entitled as Technological Pedagogical Content Knowledge of Prospective Teachers.

1.3 Operational Definition of Key Terms

Technological Pedagogical Content Knowledge (TPACK)

Technological Pedagogical Content Knowledge is defined as the teacher’s knowledge for integrating technology, pedagogy and content into their teaching strategies. In this study TPACK refers to be scores obtained by the prospective teachers of Physical Science in TPACK test.

Prospective Teachers of Physical Science

Prospective teachers of Physical Science refers to student teachers studying in B.Ed. programme for two years, with optional subject as Physical science.

1.4 Objectives of the Study

1. To construct and validate the test for measuring the Technological Pedagogical Content Knowledge of prospective teachers of Physical science.
2. To find out the level of Technological Pedagogical Content Knowledge of prospective teachers of Physical science.
3. To find out whether there is any significant difference in the mean scores of Technological Pedagogical Content Knowledge of prospective teachers of Physical science with respect to

a) Locale

b) Qualification

c) Subject Specialization

1.5 Hypotheses of the Study

1. There exists significant difference in the mean scores of Technological Knowledge of rural and urban prospective teachers of Physical science.
2. There exists significant difference in the mean scores of Pedagogical Knowledge of rural and urban prospective teachers of Physical science.
3. There exists significant difference in the mean scores of Content Knowledge of rural and urban prospective teachers of Physical science.
4. There exists significant difference in the mean scores of Pedagogical Content Knowledge of rural and urban prospective teachers of Physical science.
5. There exists significant difference in the mean scores of Technological Content Knowledge of rural and urban prospective teachers of Physical science.

6. There exists significant difference in the mean scores of Technological Pedagogical Knowledge of rural and urban prospective teachers of Physical science.
7. There exists significant difference in the mean scores of Technological Pedagogical Content Knowledge of rural and urban prospective teachers of Physical science.
8. There exists significant difference in the mean scores of Technological Knowledge of graduate and postgraduate degree of prospective teachers of Physical science.
9. There exists significant difference in the mean scores of Pedagogical Knowledge of graduate and postgraduate degree of prospective teachers of Physical science.
10. There exists significant difference in the mean scores of Content Knowledge of graduate and postgraduate degree of prospective teachers of Physical science.
11. There exists significant difference in the mean scores of Pedagogical Content Knowledge of graduate and postgraduate degree of prospective teachers of Physical science.
12. There exists significant difference in the mean scores of Technological Content Knowledge of graduate and postgraduate degree of prospective teachers of Physical science.
13. There exists significant difference in the mean scores of Technological Pedagogical Knowledge of graduate and postgraduate degree of prospective teachers of Physical science.

14. There exists significant difference in the mean scores of Technological Pedagogical Content Knowledge of graduate and postgraduate degree of prospective teachers of Physical science.
15. There exists significant difference in the mean scores of Technological Knowledge among Physical science prospective teachers specializing of Physics and Chemistry.
16. There exists significant difference in the mean scores of Pedagogical Knowledge among Physical science prospective teachers specializing of Physics and Chemistry.
17. There exists significant difference in the mean scores of Content Knowledge among Physical science prospective teachers specializing of Physics and Chemistry.
18. There exists significant difference in the mean scores of Pedagogical Content Knowledge among Physical science prospective teachers specializing of Physics and Chemistry.
19. There exists significant difference in the mean scores of Technological Content Knowledge among Physical science prospective teachers specializing of Physics and Chemistry.
20. There exists significant difference in the mean scores of Technological Pedagogical Knowledge among Physical science prospective teachers specializing of Physics and Chemistry.
21. There exists significant difference in the mean scores of Technological Pedagogical Content Knowledge among Physical science prospective teachers specializing of Physics and Chemistry.
22. There exists significant difference in the mean scores of TPACK of rural and urban prospective teachers based on locale.

23. There exists significant difference in the mean scores of TPACK of UG and PG prospective teachers based on qualification.
24. There exists significant difference in the mean scores of TPACK of physics and chemistry prospective teachers based on subject specialization.

1.6 Methodology in Brief

Method used

The investigator adopted Normative Survey Method.

Sample

The study conducted on a sample of 275 prospective teachers of Physical science.

Tools used

Technological Pedagogical Content Knowledge test developed by Prema Malathy F.G and Dr. Prasad P.S

Statistical Techniques used

For the interpretation of the data, descriptive statistics like Mean, Median, Mode, Standard deviation, and Inferential statistics like t-test, ANOVA (F-test) were used.

1.7 Delimitations of the Study

1. The sample size was restricted to 275.
2. The study was restricted to Kanniyakumari District.
3. The study was limited to prospective teachers whose optional subject is Physical Science.

1.8 Organization of the Report

Chapter I: Deals with introduction, need and significance of the study, statement of the problem, definition of key terms, objectives of the study, hypotheses of the study and delimitation of the study.

Chapter II: Deals with theoretical overview and review of related literature.

Chapter III: Deals with methodology of the present investigation. This chapter consists of method adopted for the study, tools used, sample for the study and statistical techniques used.

Chapter IV: Deals with analysis and interpretation of the collected data.

Chapter V: Deals with findings, conclusions and suggestion for further study.

CHAPTER II

REVIEW OF RELATED LITERATURE

A deliberate attempt on the part of the researcher to examine and review all types of available relevant information for finding out what has already been done or not done so far on the topic of his research study. The review of related literature involves the systematic identification, location and analysis of documents containing information related to the research problem. These documents can include articles, abstracts, reviews, monographs, dissertations, books other research reports and electronic media effort. The literature review starts with the selection of a problem for research, continues through the various stages of the research process and ends with report writing.

The phase “Review of literature” consists of two words, review and literature. The term review means to organize the knowledge of the specific area of research to evolve an edifice of knowledge to show that the proposed study would be an addition to this field. In research methodology, the term literature refers to the knowledge of a particular area of investigation of any discipline which would include theoretical, practical and its research studies.

A literature covers everything relevant that is written on a topic: books, journal articles, newspaper articles, historical records, government reports, theses and dissertations, etc. the important word is “relevant” (Ramadass, P., Aruni, A. Wilson., 2014)

Need for the Review of Related Studies

1. The researcher can establish the boundaries of his field by reviewing relevant literature. It aids in problem definition and delimitation for the researcher.
2. The researcher gains a grasp of the research methodology, or the manner in which the study is to be carried out through the evaluation of related literature. Understanding the instruments, tools and statistical techniques that have shown promise and utility in earlier research is beneficial to the research.
3. The primary goal of a thorough evaluation of previous research is to ascertain the results of studies conducted in fields where analogous ideas and approaches have been effectively used.
4. A comprehensive and thorough review process may provide essential connections with the different trends and stages in the research of scholars in one's fields of expertise, acquainting oneself with the traits, ideas, perspectives and interpretations, with the unique terminology, and the justification for carrying out ones suggested studies.
5. The researcher will be better able to create workable structure for his project by reviewing earlier, similar research initiatives. The researcher can determine which issues still need to be resolved by conducting a study of related literature. A review of related literature can be a useful tool for defining the issue, assessing its importance, developing a hypothesis, and recommending a suitable research methodology and data sources.

2.1 Theoretical Overview of the Variables Concerned

Technology integrated teaching should consider the three components content, pedagogy and technology along with the relationship among and between them. The

TPACK framework highlights complex relationships that exist between content, pedagogy and technology knowledge areas and may be a useful organizational structure for defining what it is that teachers need to know to integrate technology effectively (Archambault & Crippen, 2009).

The TPACK framework builds on Shulman's (1987) descriptions of Pedagogic Content Knowledge. The conception of TPACK has developed over time and a discreet model Mishra and Koehler (2008).

TPACK consists of seven dimensions

i. Technological Knowledge (TK)
ii. Pedagogical Knowledge (PK)
iii. Content Knowledge (CK)
iv. Pedagogical Content Knowledge (PCK)
v. Technological Content Knowledge (TCK)
vi. Technological Pedagogical Knowledge (TPK)
vii. Technological Pedagogical Content Knowledge (TPACK)

Technological Knowledge (TK)

Technology knowledge refers to an understanding of the way that technologies are used in a specific content domain. Technology knowledge demands a deeper understanding and mastery of information technology for information processing, communication and problem solving that go beyond the traditional computer literacy.

Technological knowledge is knowledge of standard technologies, such as books, chalk, and blackboard, and more advanced technologies such as the internet and digital video. This involves the skills required to operate particular technologies. In the case of digital technologies, this includes knowledge of operating systems and computer hardware and the ability to use standard sets of software tools such as word processor, spreadsheet, browser and email. Since technology is continually changing, the nature of technological knowledge needs to shift with time as well. The ability to learn and adapt to new technologies will still be important.

Pedagogical Knowledge (PK)

Pedagogical knowledge is the teacher's knowledge about the processes, practices and methods of teaching and learning. It includes understanding of how students learn, classroom management skills, lesson planning and assessment.

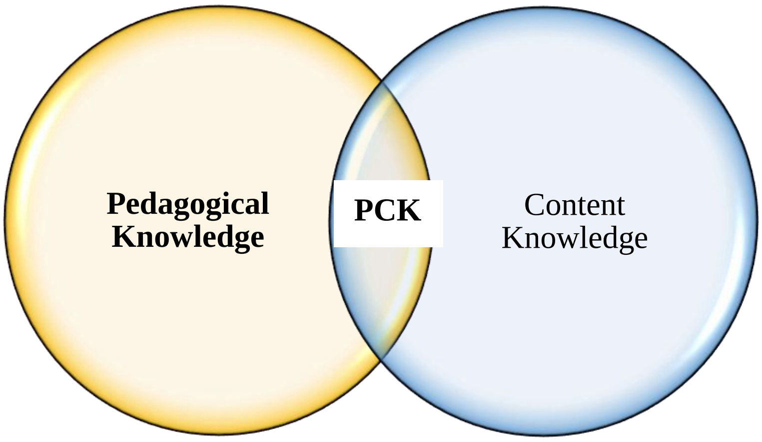
Pedagogical Knowledge is deep knowledge about the processes and practices or methods of teaching and learning how it encompasses, among other things, overall educational purposes, values and aims. This is generic form of knowledge that is involved in all issues of student learning, classroom management, lesson plan development and implementation, and student evaluation. It includes knowledge about techniques or methods to be used in the classroom, the nature of the target audience and strategies for evaluating student understanding. A teacher with deep pedagogical knowledge understands how students construct; acquire skills and develop habits of mind and positive dispositions toward learning. As such, pedagogical knowledge requires an understanding of cognitive, social and developmental theories of learning and how they apply to students in their classroom.

Content Knowledge (CK)

Content knowledge is teacher's knowledge about the subject matter to be learned or taught. It may also include knowledge of concepts, theories, conceptual frameworks as well as knowledge about accepted ways of developing knowledge.

Content Knowledge is a knowledge about the actual subject matter that is to be learned or taught. The content to be covered in high school science is very different from the content to be covered in a graduate course. Clearly, teachers must know and understand the subjects that they teach, including knowledge of facts, concepts, theories and procedures within a given field, knowledge of explanatory frameworks that organize and connect ideas and knowledge of the rules of evidence and proof. Teachers must also understand the nature of knowledge and inquiry in different fields.

Pedagogical Content Knowledge (PCK)



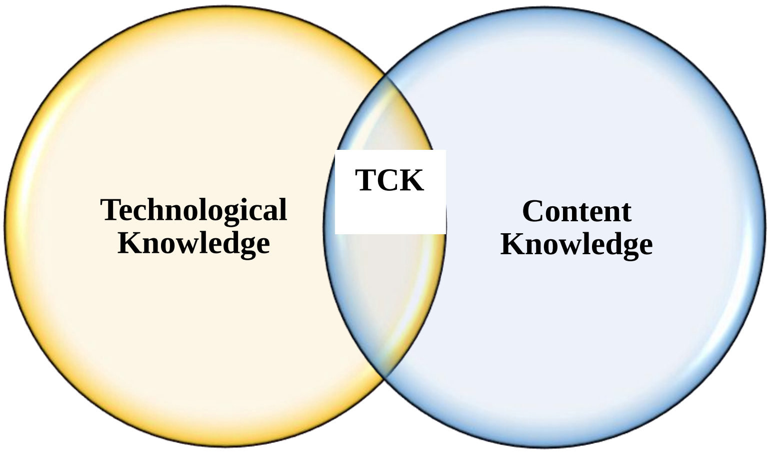
PCK is the idea of transformation of subject matter for teaching. It enables the teacher to adapt and tailor instructional materials in accordance to student's needs.

Pedagogical Content Knowledge is knowledge about how to combine pedagogy and content effectively (Shulman, 1986). This is knowledge about how to make a subject understandable to learners.

Archambault and Crippen (2009) report that PCK includes knowledge of what makes a subject difficult or easy to learn, as well as knowledge of common misconceptions and likely preconceptions students bring with them to the classroom.

It is viewed as a set of special attributes that helped someone transfer the knowledge of context to others. Schulman suggested that PCK was the best knowledge base of teaching. Pedagogic knowledge means the ‘how’ of teaching, generally acquired through education coursework and personal experience. Content knowledge on the other hand, is like ‘what’ of teaching. In Schulman’s view, PCK is a form of practical knowledge that is used by teachers to guide their actions in highly contextualized classroom settings. This form of practical knowledge includes knowledge of how to structure and represent academic content for direct teaching to students, knowledge of the common conceptions misconceptions and difficulties that students encounter when learning particular content. Knowledge of the specific teaching strategies that can be used to address student’s learning needs in particular classroom situations. Pedagogical Content Knowledge represents the blending of content and pedagogy into an understanding of how particular aspects of subject matter are organized, adapted and represented for instruction. According to Schulman, PCK is teacher interpretations and transformations of subject matter knowledge in the context of facilitating student learning. He further proposed several key elements of PCK are knowledge of representation of subject matter, understanding of students’ conceptions of the subject, general pedagogical knowledge or teaching strategies, curriculum knowledge, knowledge of educational contexts, knowledge of the purpose of education. PCK is deeply rooted in a teacher’s everyday work. However, it is not opposite to theoretical knowledge. It encompasses both theories learned during teacher presentation as well as experience gained from ongoing schooling activities. The development of PCK is influenced by factors related to the teacher’s personal background and by the context in which he or she works. PCK is deeply rooted in the experience and assets of students, their families and communities. PCK is a type of knowledge that is unique to teacher's and it is based in the manner in which teachers relate their pedagogical knowledge to their subject matter knowledge. It is the integration or the synthesis of teacher's pedagogical knowledge and their subject matter knowledge that comprises PCK.

Technological Content Knowledge (TCK)

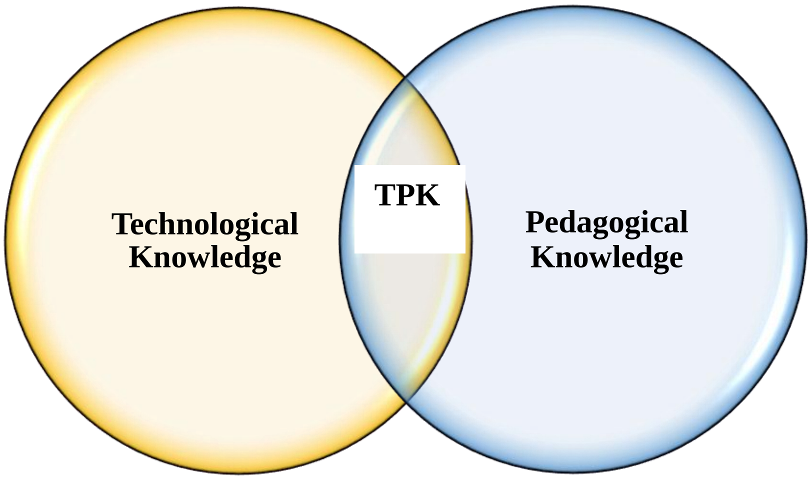


Technological content knowledge refers to knowledge about how technology may be used to provide new ways of teaching content (Niess, 2005).

For example, digital animation makes it possible for students to conceptualize how electrons are shared between atoms when chemical compounds are formed. Teacher's need to understand which specific technologies are best suited for addressing the subject matter.

Technological Content Knowledge describes knowledge of the reciprocal relationship between technology and content. Technology impacts what we know and introduces new affordances as to how we can represent certain content in new ways that was not possible before. For e.g. today students can learn about the relationship between geometric shapes and angles by touching and playing with these concepts on the screens of portable devices. Similarly visual programming software now allows even primary school students to pick up programming by designing and creating digital games.

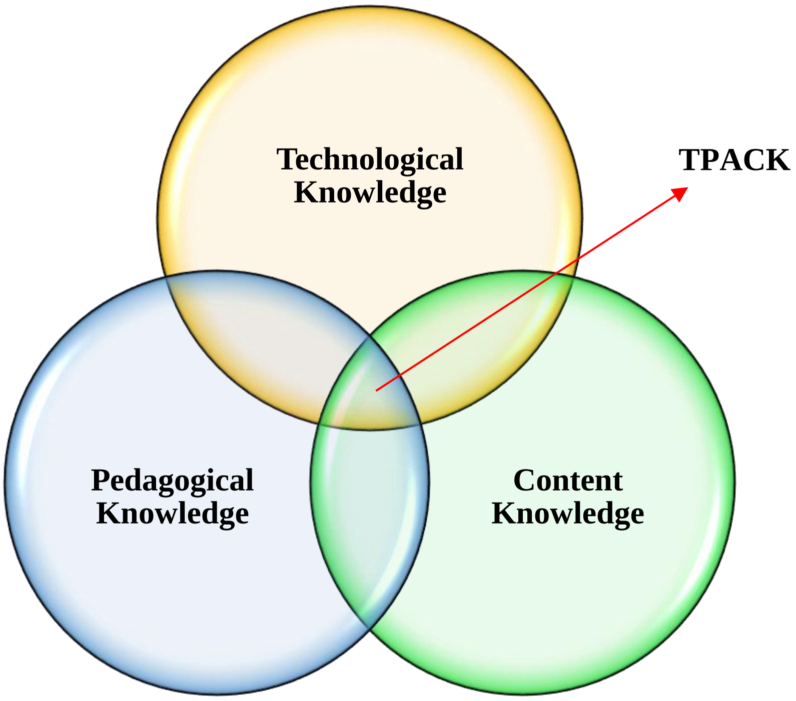
Technological Pedagogical Knowledge (TPK)



TPK refers to the understanding of how teaching and learning can change when particular technologies are used in particular ways. It is the understanding of how powerful a particular technology is helpful in transacting content.

Technological Pedagogical Knowledge is knowledge of the existence, components and capabilities of various technologies as they are used in teaching and learning settings and conversely knowing how teaching might change as result of using particular technologies. TPK identifies the reciprocal relationship between technology and pedagogy. Technology can also afford new methods and venues for teaching and ease the way certain classroom activities are implemented. For example, collaborative writing can take place with google docs instead of face-to-face meetings, extending collaborative activities over distances. Also, the advent of online learning and more recently open online courses require teachers to develop new pedagogical approaches that are appropriate for the tools at hand. Knowledge of tools for maintaining class records, attendance and grading and knowledge of generic technology-based ideas such as WebQuests, discussion boards and chat rooms can also be included in this context.

Technological Pedagogical Content Knowledge (TPACK)



TPACK is an emergent form of knowledge resulting from interaction among content, pedagogy and technology domains. It goes beyond all the three core components viz., content, pedagogy and technology. It includes an understanding of the complexity of relationships between students, teachers, content, practices and technologies (Archambault & Crippen, 2009).

TPACK influence of interrelations between of content, pedagogy and technology. For instance, in transacting the concept of image formation of spherical mirrors, teacher can choose from a variety of pedagogic techniques and technological tools. A range pedagogic technique including explanation, questioning, discussion, illustrating with diagram and technological tool like animation, video-clips, cartoons, smartboard, virtual lab etc., are available for effective transaction.

Technological Pedagogical Content Knowledge is an emergent form of knowledge that goes beyond all three components content, pedagogy and technology. This describes the synthesized knowledge of each of the bodies of knowledge described above with a focus upon how technology can be uniquely crafted to meet pedagogical needs to teach certain content in specific contexts. This knowledge is different from knowledge of a disciplinary or technology expert and also from the general pedagogical knowledge shared by teachers across disciplines. TPACK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies, pedagogical techniques that use technologies in constructive ways to teach content, knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and knowledge of how technologies can be used to build an existing knowledge. Good teaching with technology requires a shift in existing pedagogical and content domains.

2.2 Related Studies

The investigator collected studies related to knowledge of Technological Pedagogical Content Knowledge of prospective teachers. The related studies reviewed by the investigator are classified under the following two categories.

1) Studies Conducted in India
2) Studies Conducted in Abroad

A. Studies Conducted in India

Pramanik, A., and Dash, N., (2022) studied the TPACK of science teachers at higher secondary stage in covid era. The difference between government and private teachers were similar in both tools, so there was no significant difference in TPACK.

Kalaimani, K., and Stephen, D.L.G., (2022) researched the TPACK of high school teachers in Chennai. The researcher adopted the descriptive survey method for the sample of 30 high school teachers in Chennai. TPACK tool has been collected data and findings of the study revealed that there was no significant difference of high school teachers based on gender and stream of the subjects. The result of the study revealed that the levels of TPACK of high school teachers were moderate in nature.

Ajithkumar, C., and Abraham, J. (2021) evaluated the effectiveness of TPACK based self-learning e module for pre service teachers. Findings revealed that the pre-service teachers who have high TPACK would have high computer self-efficacy. The TPACK of pre service teachers had high in male and second year when compared to female and first year.

Selvi, A.J., and Ramakrishnan, K S. (2021) conducted a study on TPACK self -confidence and teaching competency among student teachers in Trichy district. The findings revealed that the level of TPACK self-confidence and teaching competency of student teachers are high. There was a positive relationship between the TPACK and self-confidence, TPACK and teaching competency of student teachers.

Jeyaraj, I., and Ramnath, R., (2021) was conducted a study the TPACK of B.Ed. student teachers in Puducherry region. The findings revealed that TPACK of B.Ed. student teachers are moderate. There exists significant difference in TPACK of student teachers with respect to degree, access of e-content and technology usage frequency in teaching learning process.

Ansari, I., and Bhatia, H. (2019) developed a module based on TPACK model for preservice science teachers revealed that TPACK of preservice teachers before module was 40% agree and 32.31% disagree, and after module 81.54% agree or strongly agree. The difference between pre-test and post-test scores was significant and large according to Wilcoxon signed rank test and Cohen's effect size.

Beri, N., and Sharma, L., (2019) investigated a study on TPACK among teacher educators in Punjab region revealed that the TPACK competencies had high in the teacher educators in Punjab region and there were statistically significant differences in the TPACK competencies of teacher educators with respect to gender, locality of college, stream and type of colleges.

Gloria and Benjamin (2018) conducted a study on attitude of teachers towards techno-pedagogy. The education system was now witnessing a paradigm shift from the traditional chalk-and-board teaching methodology to digitizing the pedagogical approach through technical 62 devices. A transformation would not only increase the capability of the teachers but would also widen the knowledge base of students so as make them competitive in the international arena. The technology orientation needs to improve in order to equip themselves to face the students belong to the digital era and also to face the challenges in the modern classroom. Technology improves learning and makes the teaching – learning process more interesting. So, the techno-pedagogical skill of the teachers has in need to be increased and also should bring positive attitude towards techno-pedagogy.

Kumar, S., and Gangmei, E., (2018) analysed a study on TPACK of secondary teacher educators of Jharkhand. This study revealed that the TPACK of teacher educator was low and 90% of teachers used smartphone but they were not able to use in the classroom for teaching learning process. So, it is big challenge for government and teacher education institution to uplift and enhance the quality of education.

Madan, N., and Umende, M. (2018) have investigated a study on job satisfaction of sr. sec. school teachers in relation to their TPACK. The findings revealed that most teachers had average TPACK. TPACK were positively significant related to job satisfaction in most of groups, except for urban female teachers who had a negatively insignificant relationship.

Thappa, S.R., and Baliya, J.N. (2018) investigated the efficacy of TPACK on self-concept and teaching aptitude of pre-service teachers revealed that the positive impact of TPACK framework-based capacity building programme module on overall self-concept and teaching aptitude of pre-service teachers.

Venkata, R.Y., and Kumar, (2018) conducted a study on intervention of technological innovation in higher education. The findings revealed that online learning opportunities has led to a range of issues in relation to accreditation that need to be addressed, such as the examination of appropriate curriculum development and pedagogical approaches for online delivery and the support and development of staff in online course delivery.

Ajithkumar, C., (2017) investigated a study on relationship between TPACK and technology anxiety of student teachers of university of Calicut revealed that majority of student teachers falls under average TPACK category and there is no significant relation between TPACK and technology anxiety of student teachers for the total sample.

Padmavathi (2017) conducted a study on preparing teachers for technology-based teaching learning using TPACK. Teachers have to understand that TPACK is not just addition of ICT to traditional teaching rather it is integrating the advantages of using ICT in a way that is appropriate to the discipline concerned and nature of the topic dealt. TPACK requires thorough understanding of PCK, knowledge of how ICT can be used to access and process subject matter.

Qasem and Viswanathappa (2016) conducted a study by blended learning approach to develop the teachers' TPACK, the sample of 60 science teacher trainees in Ibb city. The ICT knowledge scale was used based on TPACK. The findings revealed that TPACK has provided a valuable tool for assessing teacher's knowledge in the area of technology integration, the teachers' ICT knowledge was above average in two groups, and there is significant difference between experimental and control groups on ICT knowledge scale.

Scaria, S.M., and Pereira, C. (2016) investigated developing a blended learning package for enhancing techno pedagogical skills and achievement among student teachers at secondary level, that positive impact of blended learning package on techno-pedagogical skills and achievement in techno-pedagogy of student teachers at secondary level.

Gloria and Benjamin (2014) conducted a study on techno-pedagogical skills in teacher education. It is important to recognize that, teacher educators and training graduates are becoming more knowledgeable of information and communication technology outcomes (ICTs), they continue to have knowledge or skill with which to integrate those technologies into their teaching practice. Teacher educators and training graduates can play an effective role only if they are prepared in a creative, resourceful and efficient manner to use techno-pedagogical skills to nurture the students as per the demand of the changing times. Teaching with use of modern technical facilities enhances student's knowledge and improves the teaching learning process in this fast-changing complex world.

B. Studies Conducted in Abroad:

Konyak, H. (2023) studied the TPACK of prospective elementary teachers. The findings of the study revealed that prospective elementary teachers' TPACK to be above average and no significant difference was found on the basis of gender, academic level, age, and stream of study among the prospective elementary teachers.

Ali, M., & Abouelenein, M. (2022) investigated the in-service teachers' TPACK development through an adaptive e-learning environment (ALE). TPACK is an essential framework for comprehending how teachers employ technology in teaching. The experiment group improved TPACK more than the control group. The research revealed that adaptive learning training helped them to build technology-integrated lesson plans.

Masrifah, M., et al., (2022) experimented the effectiveness of using e-book based on multimodal representation and technological and pedagogical content knowledge (TPACK) to improve ICT literacy of Physics teacher. Physics teacher guide e-book was effective in increasing teachers' ICT literacy. This product has a greater impact on the increase in literacy compared to the teachers commonly used books.

Adipat, S. (2021) conducted a study to determine whether technology - enhanced content and language-integrated learning (T-CLIL) instruction. The findings demonstrated that T-CLIL instruction enhances the TPACK of preservice teachers as indicated by the consistent increase in the mean scores for all seven TPACK elements across the four separate time intervals.

Bonafini, F. C., & Lee, Y. (2021) investigated prospective teachers' TPACK and their use of mathematical action technologies as they create screencast video lessons on iPads. The results showed prospective teachers effective use of pedagogical techniques and the screencast app as an amplifier tool, according to the amplifier – reorganizer metaphor. Half of the participants used mathematics technology to confirm and expand the results they had found without technology. The other half had mathematics technology integrated into their solution exercising the balance among TPACK components. For some, their use of mathematical tool had the potential of expanding the mathematical repertoire of virtual students.

Lopez, M. Y., et al., (2021) investigated TPACK of prospective mathematics teachers at an early stage of training. The results of an investigation on the TPACK evidenced by mathematics teachers in the second year of initial training (preservice) at the Universidad Nacional, from the TPACK model perspective, on the subject of functions. The results showed that participants possess instrumental dominance over the basic forms of knowledge underlying the model.

Ramnarain, U., et al., (2021) assessed the TPACK of pre-service science teachers at a South African University. The purpose of study was to investigate preservice science teachers' proficiency levels regarding their practical knowledge of TPACK. Sample of the study consists of 103 third and fourth-year participant. The findings of the study showed that great majority of preservice science teachers have a proficiency level of 3 for their knowledge on TPACK-P. The findings could inform higher education institutions reviewing their teacher development programmes for pre-service science teacher preparedness in harnessing the affordances of ICT in their teaching.

Gee, J., & Wang, H. (2020) examined whether and how the self-selected K-5 teachers in a suburban elementary school in California demonstrated TPaCK in the integration of instructional technologies revealed patterns in teachers' problem solving that reflected differences in their levels of TPACK development. The more advanced TPACK members benefited from the CoP because other members helped them to clarify and solidify their own TPACK practices.

Jalani, G. (2020) investigated the self-assessment of prospective teachers TPACK. the targeted population was Karakoram International University. The study revealed that TPACK of prospective teachers are at moderate level and the Pearson's correlation coefficient between latent factors of TPACK ranged from 0.174 to 0.547.

Schmid, M., et al., (2020) developed a short assessment instrument for technological pedagogical content knowledge and compared the factor structure of an integrative and a transformative model revealed that the prospective teachers at Karakoram International University, the findings revealed that TPACK was considered a valid and reliable instrument for assessing pre-service teachers' TPACK. Furthermore, the internal relations of knowledge components support a transformative view of the TPACK model.

Rian, G. (2018) analysed the TPACK on Economics teachers in Cirebon City showed the factor that contributed the most on the TPACK model was Content Knowledge variable, with the role of indicator that provides the greatest contribution that was the teacher's knowledge of learning development strategy.

Kaplon-Schilis, A., and Lyublinskaya, I. (2018) analyzed the development of TPACK of pre-service elementary special education teachers enrolled in a graduate level pedagogy course integrating technology in Mathematics and Science instruction in special education and inclusive classrooms in a New York City public college, whether TK, PK, and CK are independent constructs in the TPACK for assessing the basic domains. Multiple linear regression showed that TK, PK, and CK were not predictors of the TPACK for this population. The third study was learning trajectory of a single pre-service elementary special education teacher and TPACK transfer from this course to the teaching during the induction to teaching year. The study suggested several internal and external factors affecting transfer of teacher's TPACK from her pre-service to in-service teaching experience.

Bas, G. and Senturk. C. (2018) evaluated the technological pedagogical content knowledge (TPACK) of in-service teachers. The results indicated that the in-service teachers' TPACK perceptions were affected by their gender, occupational experience, educational level, teaching level, and taking educational computer and internet use seminar variables. The results revealed that the in-service teachers' perceptions of TPACK were at a moderate level.

Dalal, M., et al., (2017) investigated professional development for international teachers: examining TPACK and technology integration decision making. Qualitative analysis of their rationales revealed that through teachers learned to consider the affordances of technology, technology access issues were pivotal in their choice and use of technology in instruction planning. With education becoming increasingly global, the study has implications for the motivation and design of technology professional development programs for international teachers.

Jen, et al., (2016) examined the in-service and pre-service science teachers' knowledge about and application of TPACK-P in Taiwan revealed that there were no significant differences between in-service and pre-service teachers' TPACK-P and that most of the participants displayed knowledge about TPACK-P at levels 2 and 3, but their application was at level 1. The validated four proficiency levels coupled with typical performances can be viewed as a roadmap of science teachers' TPACK-P suggests that further practical experiences in supportive environments are needed in science teacher education programs.

Ritter, D. (2012) studied how TPACK would be integrated within the planning process of secondary educators, and how these decisions might be affected by an educator's TPACK. The study revealed the that one's growing familiarity with the use of a specific technology could affect an educator's self-assessed TPACK score and also found that barriers can have a significant effect on an educators' decision making when deciding to use technology, and as a result affects an educator's self-assessed TPACK score.

Koh, J.H.L., et al., (2010) examined the technological pedagogical content knowledge of Singapore pre-service teachers revealed that TPACK perceptions was influenced by gender. However, the influence of age and teaching level were not strong.

2.3 Critical Review

The investigator has gone through the India as well as the foreign studies which are related to the study Technological Pedagogical Content Knowledge of prospective teachers. In the present study the investigator reviewed 17 studies conducted in India and 17 studies conducted abroad, related to TPACK. But no study has done so far in this topic. The findings of the study revealed that TPACK of prospective teachers have to improve the innovative method of technology integrated teaching in efficiency.

In recent year there is a rapid there is a rapid development in educational research. It gives a lot of materials for the study. This provides the investigator with objectives, hypothesis, method of the study, sampling techniques used for analysis of data, interpretation of data and conclusion to be drawn. The investigators, by collecting these materials become more resourceful and also obtain a number of ideas beneficial to the investigator own research with the above understanding.

CHAPTER III

METHODOLOGY

Research is a systematic attempt to obtain answers to meaningful questions about phenomena or event through the application of scientific procedures. It is an endless quest for knowledge or unending search for truth. It brings to light new knowledge or correct previous errors and misconceptions and add in an orderly way to the existing body of knowledge. Research methodology is the study of methods by which we gain knowledge.

Methodology is the mapping strategy of research. According to Woody (1984) "Methodology is a procedure adopted by the investigator in conducting investigation". Research Methodology involves various activities. They are identifying problems, review of literature, formulation of hypotheses, data collection, analysis of data, interpreting results and finally conclusion. It is a way to solve the research problem systematically. Methodology occupies a very important place in any research as the reliability of the findings depends upon the method adopted. Methodology is the science of proper modes and orders of procedures; pattern and skilfully following the same can reduce effort on one hand and ensure the success on the other. The success of any research depends on the methodology which determines the validity of the results.

According to Best and Kahn (2006), "Research may be defined as the systematic and objective analysis and recording of controlled observations that may lead to the development of generalizations, principles, or theories, resulting in prediction and possibly ultimate control of events."

According to Kothari (2009), “Research methodology is a way to systematically solve the research problems. It may be understood as a science of studying research problems. It may be understood as a studying how research is done scientifically”. It involves the systematic procedures by which the researcher starts from the initial identification of the problem to its final conclusions.

Educational Research

Educational research is the scientific field of study that examines education and learning processes and the human attributes, interactions, organizations and describe, understand and explain how learning takes place throughout a present life and how formal and informal contexts of education affect all forms of learning.

Research in education helps the teachers to become more efficient in their tasks. Educationists, researchers and teachers should combine together their resources and expertise so as to make available an effective education for maximum number of pupils. Research caused out to achieve this objective, either by professionals or by private individuals will be of immense help to classroom teachers to practice and facilitate their professional growth.

The methodology chapter for the present study is divided into two major sections.

Section A - Test Development

Section B – Plan and Procedure of the study

Section: A Test Development

Procedure of Tool Development

The tool for the present study prepared by Prema Malathy F.G and Dr. Prasad P.S meant to find out Technological Pedagogical Content Knowledge of Prospective Teachers.

Certain important consideration and procedures are followed for the scientific preparation of the tool.

The major steps followed in the development of Technological Pedagogical Content Knowledge test are

i. Planning of the test
ii. Item Writing
iii. Item Editing
iv. Arrangement of Items
v. Preliminary try-out
vi. Draft form of the test
vii. Final tryout
viii. Scoring
ix. Item analysis
x. Item selection
xi. Establishing Validity and Reliability

Planning of the test

The test prepared by Prema Malathy F.G and Dr. Prasad P.S aimed to measuring the Technological Pedagogical Content Knowledge of prospective teachers having the dimensions TK, PK, CK, PCK, TCK, TPK, TPACK.

Item writing

Writing of the suitable items is one of the important steps in the construction of any research tool. The items were collected related to Technological Pedagogical Content Knowledge of prospective teachers. It was collected on the basis of a detailed review of literature related to the problem under study. The investigator collected ideas from magazines, journals, educational reports, digital sources, etc. The test contains multiple choice questions alone. The method used in item writing is the fixed response method.

Item Editing

Editing the items need much care and it is the process of checking and scrutinizing items. The items were referred to the experts for modification. As per suggestions, the ambiguous items were written in multiple choice types and for each question four answers were given.

Arrangement of Items

All the items were grouped and arranged in a coherent order to increase the interest of the respondents and maintain the attention for responding.

Preliminary Try-out

The preliminary try-out of the test is done to find out the practicability of the items. The difficulties in responding the items and a rough estimate of the time limit for responding the items were noted. This step helped the investigator to modify certain items which were vague and questionable. For this purpose, the test was given to 40 prospective teachers of Kanniyakumari District.

Draft form of the test

The first draft was prepared by writing the item with the provisions to mark the response. The TPACK consists of seven dimensions are Technological Knowledge, Pedagogical Knowledge, Content Knowledge, Pedagogical Content Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge, Technological Pedagogical Content Knowledge. Each dimension consists of 20 items. It was printed in English. Necessary instruction for the respondents was also printed. A sample copy of the draft from the best is given, which were selected randomly from the population.

Scoring

The collected response sheets were scored with the help of a scoring key prepared by the investigator. The responses were scored by each correct response one mark and each wrong response zero mark was given.

Final try-out

The tool was administered to a sample of 100 prospective teachers of various Colleges of Education in Kanniyakumari District for the purpose of item analysis. They were selected randomly from the population.

Item analysis

Item can be analyzed qualitatively in terms of their content and quantitatively in terms of their statistical properties. Item analysis is a statistical technique which is used for selecting and rejecting the items of a test on the basis of their discriminative power.

The total score for each dimension for all the items was then found out. One point credit was given to each correct answer. For carrying out item analysis, the answer scripts in the final try-out conducted is arranged in the descending order, from the top score to the bottom score. 27% of the answer script from the top is designated as ‘Higher Group’ and 27% of the script in the bottom constitute the ‘Lower Group’.

For every individual item the number of students who answered it correctly in the two groups should be counted. The Discriminative Power (DP) for each test item could be found out by using the following formula.

$$\text{Discriminative Power, DP} = \frac{R_H - R_L}{N}$$

Where,

R_H = Number of correct responses in the higher group

R_L = Number of correct responses in the lower group

N = Number of Prospective Teachers in the higher or lower group

Item selection

The draft form of TPACK test contains 140 items. The selected items had discriminative power. After the item analysis the final test consisted 77 items. The details of item selection are given in Table 3.1

Table 3.1

Details of Items selected based on discriminative power

Items No.	Higher Right answer (R_H)	Lower Right answer (R_L)	Discriminative Power, DP $= \frac{R_H - R_L}{N}$	Selected Items
Technological Knowledge (TK)				
1*	20	8	0.444*	Selected
2	19	13	0.222	-
3*	17	5	0.444*	Selected
4*	21	12	0.333*	Selected
5	20	16	0.148	-
6*	22	9	0.481*	Selected
7	11	4	0.259	-
8	26	18	0.296	-
9	2	5	-0.111	-
10	9	11	-0.074	-
11	19	19	0	-
12*	20	9	0.407*	Selected
13	13	8	0.185	-
14*	27	13	0.519*	Selected
15	1	9	-0.296	-
16	20	13	0.259	-
17	27	22	0.185	-
18*	21	12	0.333*	Selected
19*	25	16	0.333*	Selected
20*	25	15	0.370*	Selected

Pedagogical Knowledge (PK)				
21	10	12	-0.074	-
22*	15	3	0.444*	Selected
23	7	8	-0.037	-
24	14	19	-0.185	-
25	4	3	0.037	-
26*	25	8	0.630*	Selected
27	27	22	0.185	-
28*	25	16	0.333*	Selected
29	17	10	0.259	-
30	14	9	0.185	-
31*	20	10	0.370*	Selected
32	22	3	0.704	-
33*	27	17	0.370*	Selected
34	8	10	-0.074	-
35*	16	4	0.444*	Selected
36*	25	8	0.630*	Selected
37	7	10	-0.111	-
38*	19	9	0.370*	Selected
39*	26	8	0.667*	Selected
40	19	14	0.185	-
Content Knowledge (CK)				
41	13	11	0.074	-
42	27	26	0.037	-
43*	26	8	0.667*	Selected
44	13	8	0.185	-
45	4	4	0	-
46	2	9	-0.259	-
47*	24	14	0.370*	Selected
48	7	11	-0.148	-
49	26	18	0.296	-
50*	27	13	0.519*	Selected
51*	22	8	0.519*	Selected
52	26	18	0.296	-
53	1	9	-0.296	-

54*	20	2	0.667*	Selected
55	6	6	0	-
56*	24	10	0.519*	Selected
57	5	0	0.185	-
58*	23	10	0.481*	Selected
59*	22	5	0.630*	Selected
60*	21	9	0.444*	Selected
Pedagogical Content Knowledge (PCK)				
61	14	11	0.111	-
62*	26	12	0.519*	Selected
63*	21	11	0.370*	Selected
64*	24	7	0.630*	Selected
65*	27	18	0.333*	Selected
66*	19	4	0.556*	Selected
67*	13	0	0.481*	Selected
68	21	15	0.222	-
69	25	17	0.296	-
70*	23	9	0.519*	Selected
71	14	9	0.185	-
72*	19	7	0.444*	Selected
73	12	5	0.259	-
74*	27	9	0.667*	Selected
75	18	15	0.111	-
76*	23	7	0.593*	selected
77*	18	9	0.333*	Selected
78*	26	8	0.667*	Selected
79*	20	4	0.593*	Selected
80	7	6	0.037	-
Technological Content Knowledge (TCK)				
81	14	12	0.074	-
82*	25	11	0.519*	Selected
83*	23	8	0.556*	Selected
84*	24	5	0.704*	Selected
85	3	4	-0.037	-
86*	26	10	0.593*	Selected
87	15	9	0.222	-
88	5	9	-0.148	-
89	2	5	-0.111	-
90*	19	4	0.556*	Selected

91*	19	7	0.444*	Selected
92*	19	10	0.333*	Selected
93	23	16	0.259	-
94	11	9	0.074	-
95*	18	6	0.444*	Selected
96*	18	8	0.370*	Selected
97*	20	6	0.519*	Selected
98*	20	7	0.481*	Selected
99*	17	4	0.481*	Selected
100*	23	13	0.370*	Selected
Technological Pedagogical Knowledge (TPK)				
101	17	9	0.296	-
102	3	5	-0.074	-
103	9	1	0.296	-
104	3	2	0.037	-
105*	20	11	0.333*	Selected
106*	19	6	0.481*	Selected
107	15	10	0.185	-
108*	14	5	0.333*	Selected
109	1	4	-0.111	-
110*	23	6	0.630*	Selected
111	14	8	0.222	-
112*	25	16	0.333*	Selected
113*	17	4	0.481*	Selected
114*	23	12	0.407*	Selected
115*	24	9	0.556*	Selected
116*	22	10	0.444*	Selected
117	19	12	0.259	-
118*	13	3	0.370*	Selected
119	1	2	-0.037	-
120*	19	5	0.519*	Selected

Technological Pedagogical Content Knowledge (TPACK)				
121*	24	11	0.481*	Selected
122*	17	8	0.333*	Selected
123*	21	6	0.556*	Selected
124	22	0	0.815	-
125*	17	2	0.556*	Selected
126	11	8	0.111	-
127	14	7	0.259	-
128	4	4	0	-
129	13	7	0.222	-
130*	21	12	0.333*	Selected
131*	23	9	0.519*	Selected
132	23	16	0.259	-
133	16	9	0.259	-
134*	18	6	0.444*	Selected
135*	20	5	0.556*	Selected
136*	16	3	0.481*	Selected
137*	26	9	0.630*	Selected
138*	23	5	0.667*	Selected
139*	21	3	0.667*	Selected
140*	22	6	0.593*	Selected

Selected Items:

Technological Knowledge: 9

Pedagogical Knowledge: 9

Content Knowledge: 9

Pedagogical Content Knowledge: 13

Technological Content Knowledge: 13

Technological Pedagogical Knowledge: 11

Technological Pedagogical Content Knowledge:13

Note: * Indicates selected items

Format of the Final Test

The investigator selected the item after the data analysis to form this test. It consists of total 77 items. The final form of the Technological Pedagogical Content Knowledge test was appended in Appendix – D.

Establishing Validity and Reliability

For any data collection process to be effective, validity and reliability are crucial.

a) Validity

When a test assesses the things, it was intended to measure, it is considered legitimate. Best (1978) clarifies, "A test possess validity to the extent that it claims to measure". According to Patten (2007), "An instrument is valid to the extent that it measures what it is designed to measure and accurately performs the functions it is purported to perform". Face validity and Content validity are the two primary forms of validity that have been established for this tool.

i) Face validity

When a tool appears to measure what it claims to measure, it is said to have face validity. Experts Dr. S. Sree Latha, Dr. K. Rajeswari, Dr. R.P. Deepa, and Dr. V.S. Pavithra Kumar, feedback was obtained once the tool was given to them in order to assess the tool pertinent goals. Every item on the test has the ability to reflect the Technological Pedagogical Content Knowledge of Prospective Teachers, as can be shown by closely examining the term connection. Face validity of the instrument was thus established.

ii) Content Validity

The test content validity was further proved by confirming the extent to which the test's subject was covered in genuine literature and by consulting experts' opinions. They determined that the tools content validity is moderate.

b) Reliability

A test is considered dependable if it regularly measures the same thing. There have been very few measurement errors in tests with a high reliability coefficient. A reliable test yields similar results after multiple administrations and remains steady across all measures. A test's validity can be evaluated using a variety of techniques, including rests, retests, split half methods, rational methods, etc.

In the present study investigation, the reliability co-efficient was found out by split half method. It measures the degree of homogeneity of items. The reliability correlation co-efficient of the test is calculated using Spearmen Brown Prophecy formula found to be 0.7806 showing satisfactory reliability (N=100).

Formula

Spearmen Brown Prophecy, $r = 2r_1 / (1 + r_1)$

where,

r = Reliability correlation coefficient for the whole test

r_1 = split -half reliability coefficient (the actual correlation between the halves of the test)

Split half

In the test or a questionnaire, can calculate the resulting scores for each half of the items and then compare the two scores. But then the results will depend on the method of splitting the instruments in two halves. For example, the first and the second half of the questions, even and uneven numbers of the questions, random allocation of questions to one or the other half. For excluding effects of the position of the questions, the internal consistency is calculated. For doing this will treat each question separately like independent tests and compute the correlation between the results.

Table 3.2

Reliability Analysis

Reliability Analysis	
Number of samples	100
Number of Items	77
Correlation between Odd half and Even half	0.6401
Reliability Coefficient	0.7806

From table 3.2, it is clear that the number of samples 100, the number of items 77, correlation between odd half and even half 0.6401, and the reliability coefficient of the test is found to be 0.7806. Then it shows that the test is highly reliable.

Section: B - Plan and Procedure of the Study

3.1 Method Adopted for the Study

The selection of a method and a specific design within the method appropriate in investigation a research problem depends upon the kind of data that the problem entails. However, the method selected should be in harmony with scientific principles and adequate enough to lead to dependable generalization.

The present study attempts to find out the knowledge of Technological Pedagogical Content Knowledge of Prospective Teachers of Physical Science. Since the problem selected is concerned with ‘survey’ type, the investigator has selected normative survey method for conducting the present study.

Normative Survey Method

The term “normative survey” typically refers to a kind of research that aims to determine what is average or normal in the present. In educational research, the normative survey method is widely used.

It is an investigative technique that aims to characterize and explain current circumstances, behaviours, procedures, trends, attitudes, beliefs, among other things. It is focused on occurrences that are regular under normal circumstances.

Survey method is conducted to collect detailed description of existing phenomenon with the intent of employing data to justify current conditions and practices are to make more intelligent plans for improving them. The objective of this is not only to analyze, interpret and report the status of an institution, a group or area under to guide practice in the immediate future but also to determine the adequacy of status by comparing it with established standards.

Survey studies may take different forms depending upon the scope, nature and purpose of the problem under investigation. This may be broad or narrow in some surveys encompass several countries, state, district, city, school system or some other unit. Survey data may be collected from every unit of a population or from a representative sample.

Normative survey method studies describe and interprets what exists at present. They are concerned with existing conditions or relations, prevailing, practices, beliefs, attitudes, ongoing processes and the emerging trends. Such investigations are variously termed in research literature as descriptive survey, normative survey, status studies or trend analysis.

Characteristics of Normative Survey Method

According to Sharma, R.A. (2007) the major characteristics of survey method of research were noted as,

1. The survey method gathers data from a relatively large number of cases at a time.
2. It is essentially cross-sectional.
3. It is not concerned with the characteristics of the individual.
4. It requires experts' imaginative planning.
5. It requires careful analysis and interpretation of the data gathered.
6. It requires logical and skilful reporting of the findings.
7. It involves definite objectives.
8. Surveys vary greatly in complexity.
9. It suggests the course of future.
10. It determines the present trends and solves current problems.

Purpose of Survey

1. It provides necessary information which helps the administrator for making decisions.
2. It makes suggestion about the direction of future research.
3. It is helpful for creating research tools like questionnaires, checklists and opinionnaires.
4. It ensures historical context by providing a number of cross-sectional images taken under similar conditions at different times.

3.2 Population and Sample

The present study was conducted on a population of Prospective teachers of Physical Science in various Colleges of Education in Kanniyakumari District during the academic year 2022-2024.

The present study is conducted on a sample of 275 Prospective teachers of Physical Science who are studying in various colleges of Education of Kanniyakumari District. Simple random sampling technique was used to select the sample.

The details of colleges and number of Prospective teachers from each college are given in table 3.3

Table 3.3

Details of the sample selected for the study

Sl.No.	Names of College of Education	Sample Size
1.	White Memorial College of Education, Attoor	13
2.	Christian College of Education, Marthandam	30
3.	Muslim College of Education, Thiruvithancode	9
4.	Bethesda College of Education for Women, Bethelpuram	29
5.	S.T. Hindu College of Education, Nagercoil	13
6.	Pope John Paul II College of Education, Mulagumoodu	17
7.	Mar Chrysostom College of Education, Kirathoor	11
8.	James College of Education, Kanjikulam	8
9.	Good Shepherd College of Education, Nagercoil	7
10.	Grace College of Education, Padanthalumoodu	9
11.	N.V.K.S.D. College of Education, Attoor	36
12.	Immanuel Arasar B.Ed. College of Education, Nattalam	26
13.	Ponjesly College of Education, Nagercoil	10
14.	Bethlahem College of Education, Karungal	26
15.	Amrita College of Education, Erachakulam	11
16.	R.P.A. College of Education, Mamoottukadai	9
17.	Siddhartha College of Teacher Education, Manjalumoodu	7
18.	Koottalumoodu Arulmigu Bhadreshwari Devasthanam College of Education, Koottalumoodu	4
	Total	275

3.3 Distribution of the sample based on background variables

Table 3.4.1

Distribution of the sample based on Locale

Locale	Count	Percent
Rural	150	54.55
Urban	125	45.45

From the table 3.4.1, it is clear that the sample consists of both rural (150) and urban (125) prospective teachers. The percentages corresponding to rural and urban prospective teachers are 54.55% and 45.45% respectively.

Figure 3.1

Percentage of sample based on locale

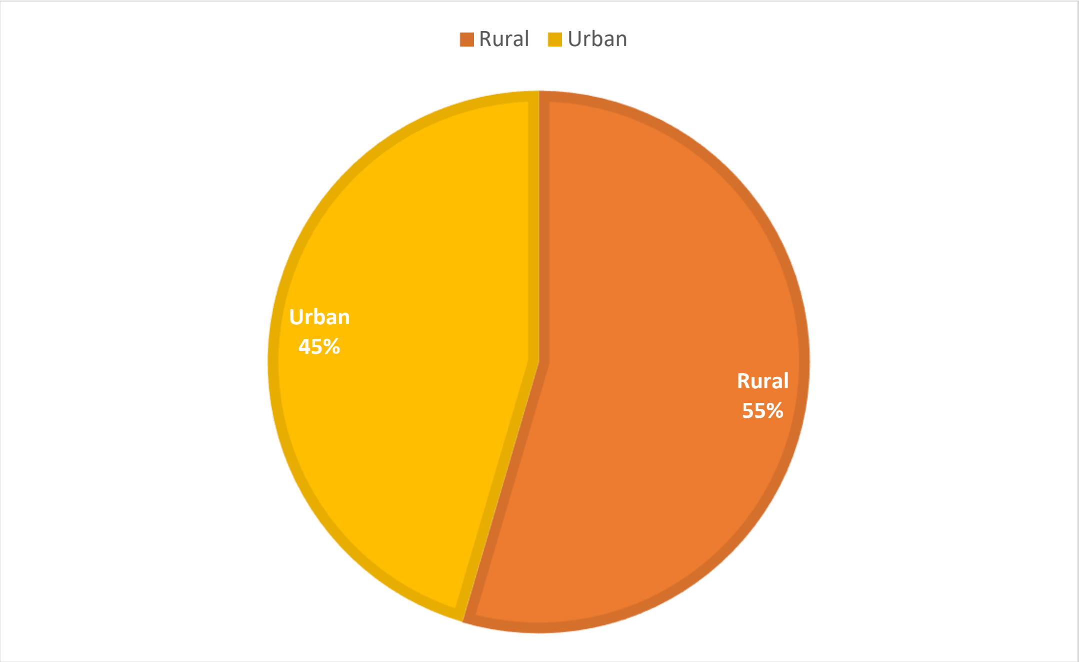


Table 3.4.2

Distribution of the sample based on Qualification

Qualification	Count	Percent
UG	217	78.91
PG	58	21.09

From the table 3.4.2, it is clear that sample consists of both UG (217) and PG (58) prospective teachers. The percentages corresponding to UG and PG prospective teachers are 78.91% and 21.09% respectively.

Figure 3.2

Percentage of sample based on graduate

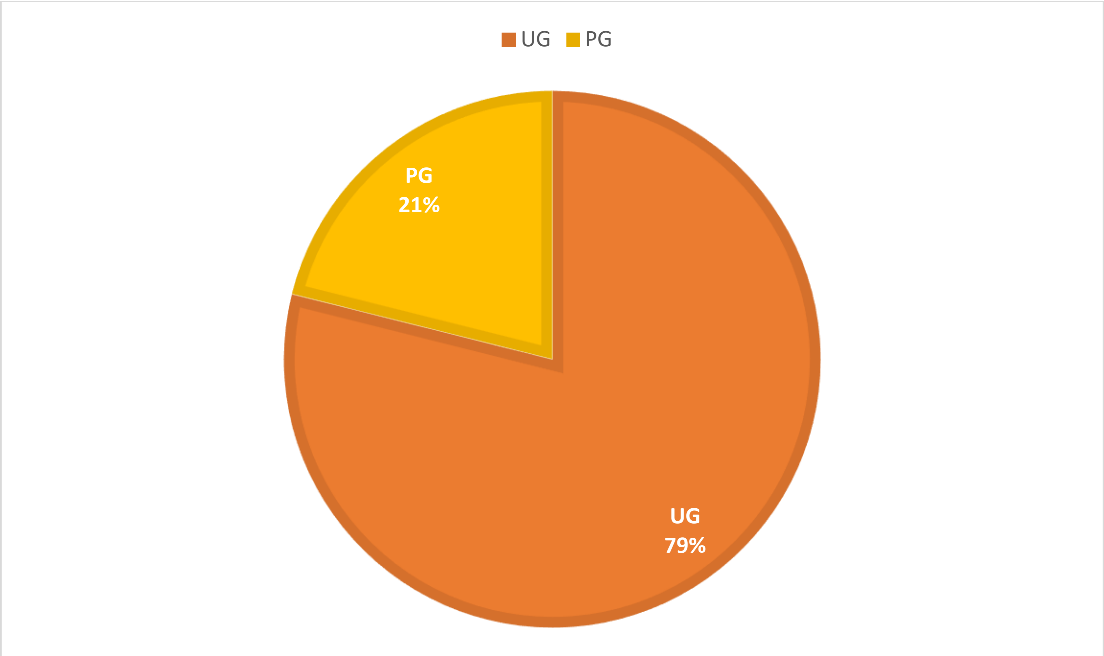


Table 3.4.3

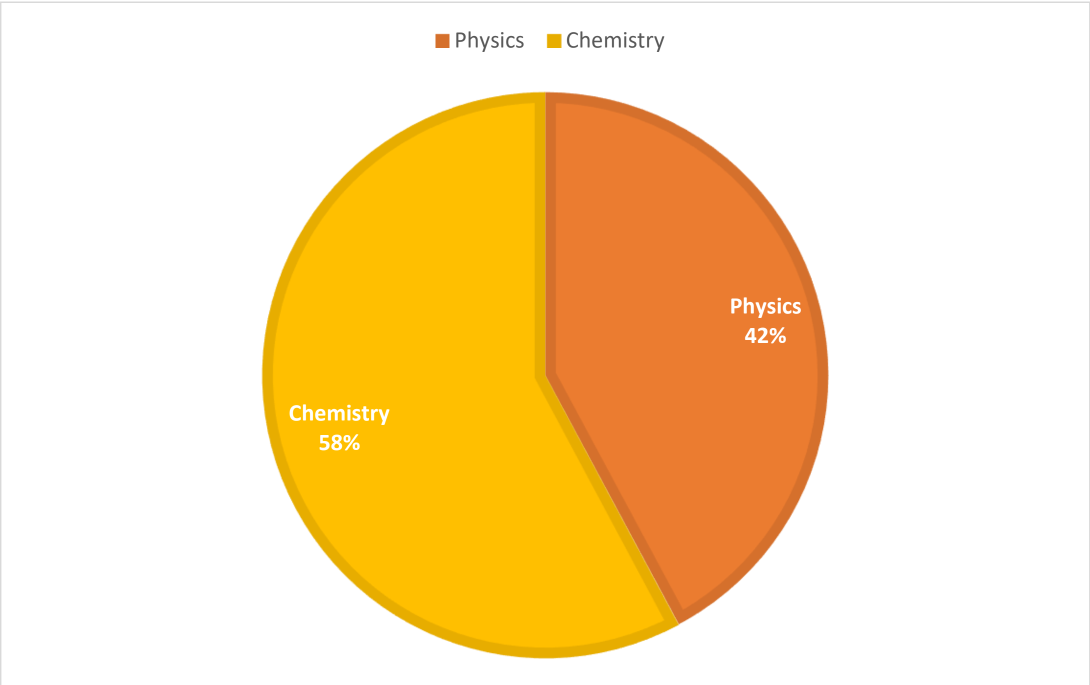
Distribution of the sample based of Subject Specialization

Subject Specialization	Count	Percent
Physics	116	42.18
Chemistry	159	57.82

From the table 3.4.3, it is clear that the sample consists of both Physics (116) and Chemistry (159) prospective teachers. The percentages corresponding to Physics and Chemistry prospective teachers are 42.18% and 57.82% respectively.

Figure 3.3

Percentage of sample based on subject specialization



3.3 Tools used in the Present Study

For collecting the data required for the study of the problem one may have to use various, scientific devices for gathering facts related to the study. These devices employed as mean are called tools. The selection to suitable instrument or tool is too vital importance and therefore the investigator used the following tool for data collection.

a) Technological Pedagogical Content Knowledge Test.

b) General information sheet.

a) Test

i. The test is simple and seeks responses in the form of four options. A right answer on the test of each item indicates one mark. The test consists of 77 items. The medium of the test is in English.

ii. The test consists of seven dimensions based on TPACK in Physical Science.

iii. The dimensions are TK, PK, CK, PCK, TCK, TPK, TPACK.

b) General information sheet

General information sheet is prepared to collect data regarding locale, subject specialization, and graduate.

Data were collected from different Colleges of Education of Kanniyakumari district. The investigator personally visited the different colleges of education after seeking permission from the principal of college concerned. The test was administered to prospective teachers. A rapport was established with the respondents before the administration of the test. The students were first asked to fill up the general information sheet. After filling all the items in the general information sheet, the investigator gave necessary directions to fill completely and correctly all the items of statements. They were asked to fill all the items in each dimension by putting a tick mark for the responses. After completing the items by all the students, the investigator carefully collected all the statement along with the general data sheet.

Scoring and Tabulation

The collected response sheets were scored systematically by the investigator for a right answer the score given was ‘1’ mark and wrong answer score given was ‘zero’ mark.

3.4 Statistical Techniques used for the Study

Statistical Techniques are very important for any research. The relevant statistical techniques help the investigator to analyze and interpret the data meaningfully in the study. In the present study the investigator used the following statistical techniques.

i) Percentage Analysis

ii) t-Test

iii) ANOVA followed by Scheffe’s Procedure

1. Percentage Analysis

Percentage is used for the comparative study of fraction. It always represents for per hundred and always calculated on 100.

The following are the levels in percentage analysis

High level refers to the scores equal to or greater than (Mean + 1 SD).

Low level refers to the scores equal to or less than (Mean -1 SD).

The in between scores are at the average level.

2. Test of Significance (t Test)

It is used for finding the significant level of difference between two groups of population. From the mean and standard deviation, t values can be calculated. If obtained t value is 2.58 and above, then level of significance is at 0.0l. if the t value is between 1.96 and 2.58 significant level is 0.05 levels and if the t value is below 1.96 the difference is not significant.

The formula for calculating the t value is given by,

$$t = \frac{m_1 \sim m_2}{\sqrt{\frac{\sigma_1^2}{N_1} - \frac{\sigma_2^2}{N_2}}}$$

Where,

m_1 = mean of the first sample

m_2 = mean of the second sample

σ_1 = standard deviation of first sample

σ_2 = standard deviation of second sample

N_1 = Total number of frequency of first sample

N_2 = Total number of frequency of second sample

3. Analysis of variance (ANOVA)

F- test or Analysis of variance method is an improvement over t test. This one method is derived by R.A Fisher in 1923. The F test is used for testing the significance of difference of more than two means simultaneously. The composite procedure for testing the difference between several sample means is known as analysis of variance.

$$\mathrm{F-Ratio} = \frac{\text{mean square variance between group}}{\text{mean square variance within group}}$$

Scheffe's procedure

If the F- ratio is significant, the post hoc is used to find out the significant difference between the groups. In such cases, the comparison of the difference between the means for any two groups is done using Scheffe's procedure (Scheffe's, 1957). Scheffe's test is one of the well-known multiple group comparison tests.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

Analysis and Interpretation of data is one of the important steps in the research process. It means studying the organized material in order to discover the inherent facts. It is the application of deductive and inductive logic to examine critically the results obtained in the light of the previous studies. According to Koul (2007) "a researcher must know the strength and weakness of the statistical methods which he uses so that he may not mislead or be misleads by such methods". According to Rummel (1970) "the analysis and interpretation of data involve the objective material in the possession of the research and his subjective reactions and desires to derive from the data inherent meaning in their relation to the problem". Analysis of data means studying the tabulated materials in order to determine the inherent facts. It involves breaking down existing complex factors into simpler parts and putting the parts together in new arrangements for the purpose of interpretation. The term analysis refers to the computation of certain measures along with searching of patterns of relationship that exists among the data group. Interpretation aims at the critical examining of the results in the light of the previous studies.

Data collected by the investigator get their meaning when they are subjected to statistical analysis, which describes the characteristics of the data and will give the investigation an insight into the problem. The result of the analysis along with the interpretation is presented in this chapter.

4.1 Preliminary Analysis

Table 4.1.1

Descriptive statistics for Technological Knowledge

Mean	Standard Deviation	Count
7.44	1.44	275

From the table 4.1.1, it is clear that the arithmetic mean obtained for the total sample is 7.44. The value obtained for standard deviation is 1.44.

Table 4.1.2

Descriptive statistics for Pedagogical Knowledge

Mean	Standard Deviation	Count
7.67	1.54	275

From the table 4.1.2, it is clear that the arithmetic mean obtained for the total sample is 7.67. The value obtained for standard deviation is 1.54.

Table 4.1.3

Descriptive statistics for Content Knowledge

Mean	Standard Deviation	Count
7.44	1.08	275

From table 4.1.3, it is clear that the arithmetic mean obtained for the total sample is 7.44. The value obtained for standard deviation is 1.08.

Table 4.1.4

Descriptive statistics for Pedagogical Content Knowledge

Mean	Standard Deviation	Count
10.74	1.97	275

From the table 4.1.4, it is clear that the arithmetic mean obtained for the total sample is 10.74. The value obtained for standard deviation is 1.97.

Table 4.1.5

Descriptive statistics for Technological Content Knowledge

Mean	Standard Deviation	Count
10.29	2.31	275

From the table 4.1.5, it is clear that the arithmetic mean obtained for the total sample is 10.29. The value obtained for standard deviation is 2.31.

Table 4.1.6

Descriptive statistics for Technological Pedagogical Knowledge

Mean	Standard Deviation	Count
8.14	1.97	275

From the table 4.1.6, it is clear that the arithmetic mean obtained for the total sample is 8.14. The value obtained for standard deviation is 1.97.

Table 4.1.7

Descriptive statistics for Technological Pedagogical Content Knowledge

Mean	Standard Deviation	Count
9.17	4.31	275

From the table 4.1.7, it is clear that the arithmetic mean obtained for the total sample is 9.17. The value obtained for standard deviation is 4.31.

Table 4.1.8

Descriptive statistics for TPACK

Mean	Standard Deviation	Count
60.87	6.78	275

From the table 4.1.8, it is clear that the arithmetic mean obtained for the total sample is 60.87. The value obtained for standard deviation is 6.78.

4.2 Percentage Analysis

Table 4.2.1

Percentage distribution levels of different levels of Technological Knowledge

Technological Knowledge	Count	Percent
Low	20	7.27
Moderate	167	60.73
High	88	32
Total	275	100

From the table 4.2.1, it is clear that 7.27% of prospective teachers have low level of technological knowledge. 60.73% of them have moderate level of technological knowledge and 32% them have high level of technological knowledge.

Figure 4.1

Percentage of Technological Knowledge

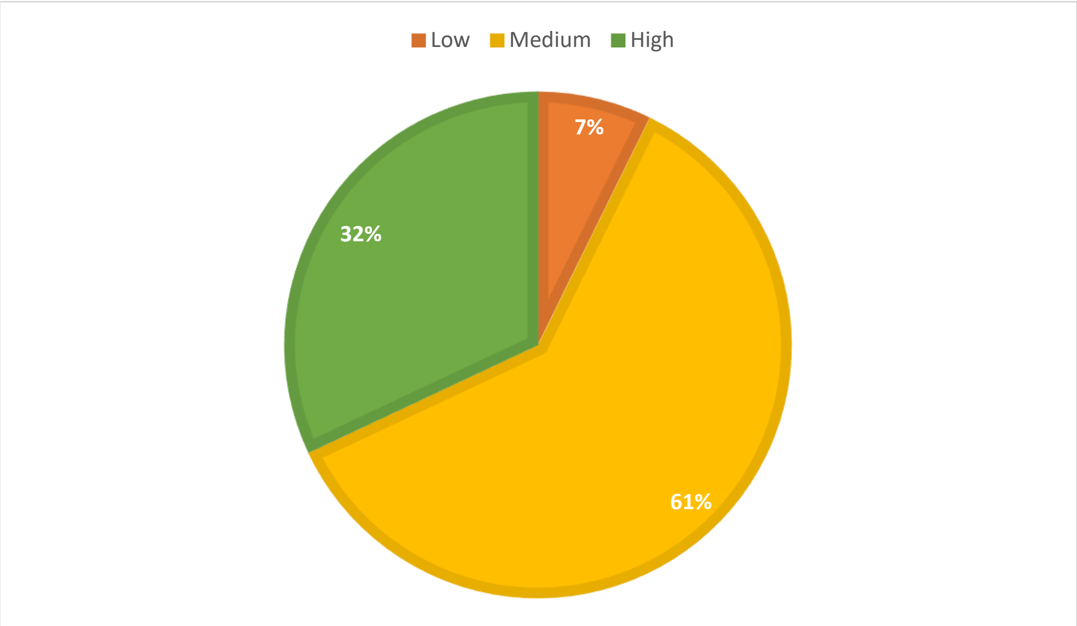


Table 4.2.2

Percentage distribution levels of different levels of Pedagogical Knowledge

Pedagogical Knowledge	Count	Percent
Low	86	31.27
Moderate	189	68.73
High	0	0
Total	275	100

From the table 4.2.2, it is clear that 31.27% of prospective teachers have low level of pedagogical knowledge and the 68.73% of prospective teachers have moderate level of pedagogical knowledge.

Figure 4.2

Percentage of Pedagogical Knowledge

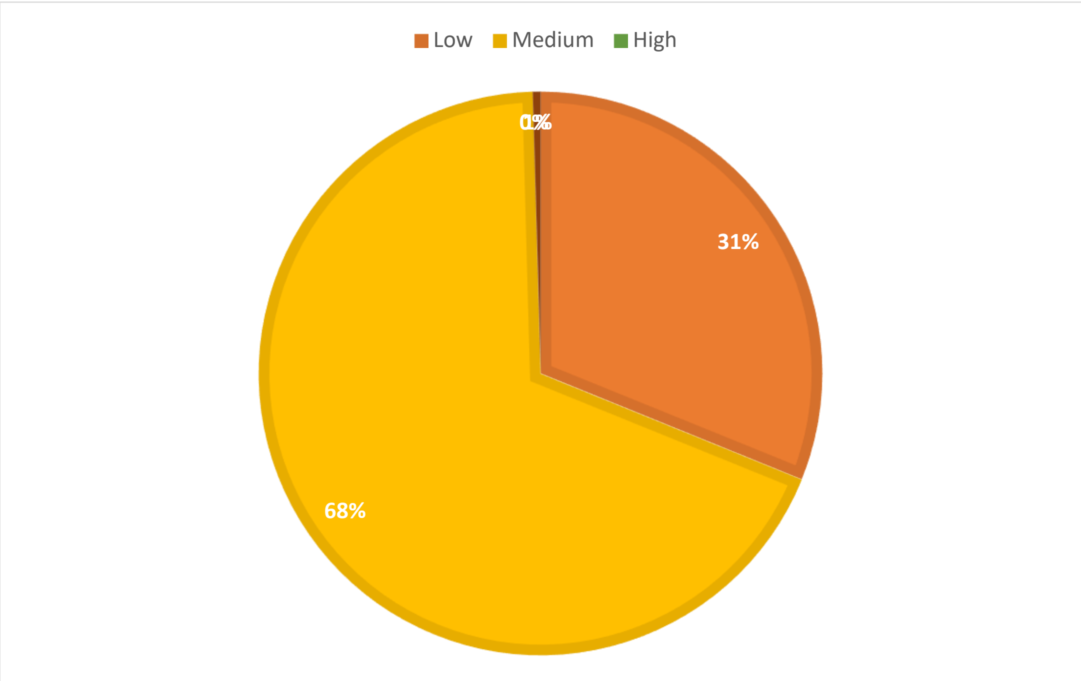


Table 4.2.3

Percentage distribution of different levels of Content Knowledge

Content Knowledge	Count	Percent
Low	37	13.45
Moderate	210	76.36
High	28	10.19
Total	275	100

From the table 4.2.3, it is clear that 13.45% of prospective teachers have low level of content knowledge. 76.36% of them have moderate level of Content knowledge and 10.19% of them have high level of content knowledge.

Figure 4.3

Percentage of Content Knowledge

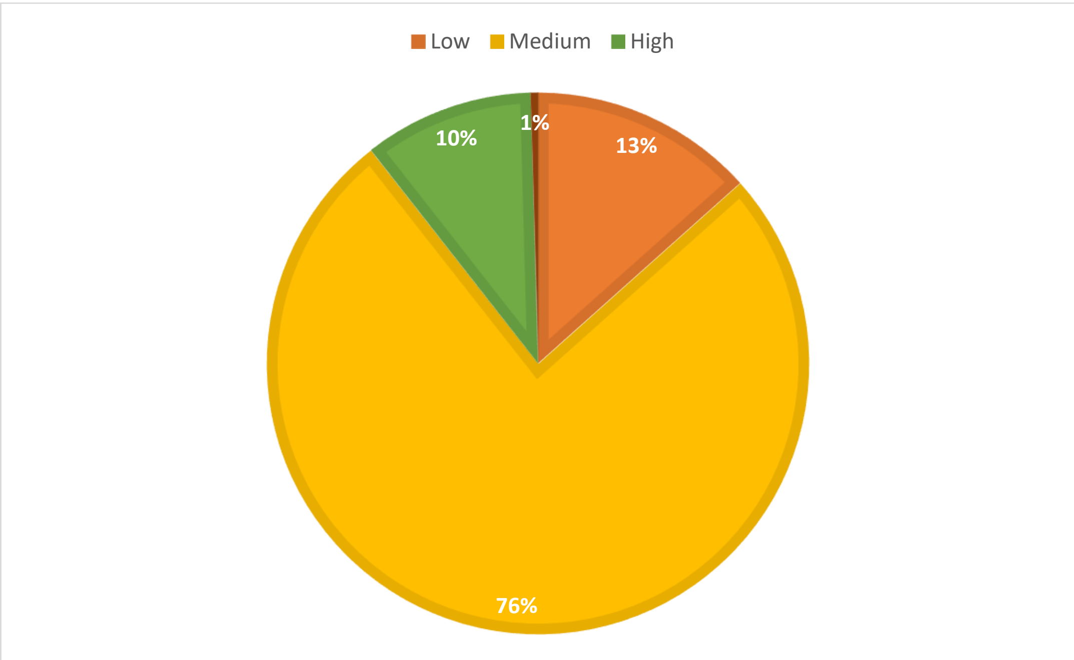


Table 4.2.4

Percentage distribution of different levels of Pedagogical Content Knowledge

Pedagogical Content Knowledge	Count	Percent
Low	66	24
Moderate	156	56.73
High	53	19.27
Total	275	100

From the table 4.2.4, it is clear that 24% of prospective teachers have low level of pedagogical content knowledge. 56.73% of them have moderate level of pedagogical content knowledge and 19.27% of them have high level of pedagogical content knowledge.

Figure 4.4

Percentage of Pedagogical Content Knowledge

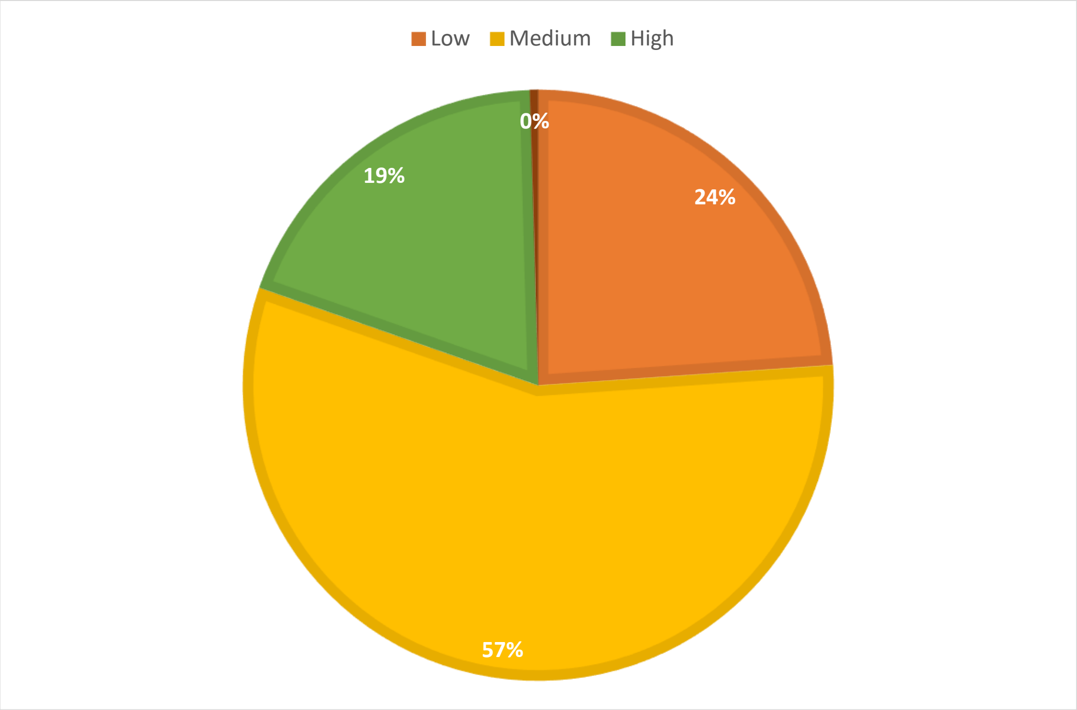


Table 4.2.5

Percentage distribution of different levels of Technological Content Knowledge.

Technological Content Knowledge	Count	Percent
Low	59	21.45
Moderate	144	52.36
High	72	26.19
Total	275	100

From the table 4.2.5, it is clear that 21.45% of prospective teachers have low level of technological content knowledge. 52.36% of them have moderate level of technological content knowledge and 26.19% of them have high level of technological content knowledge.

Figure 4.5

Percentage of Technological Content Knowledge

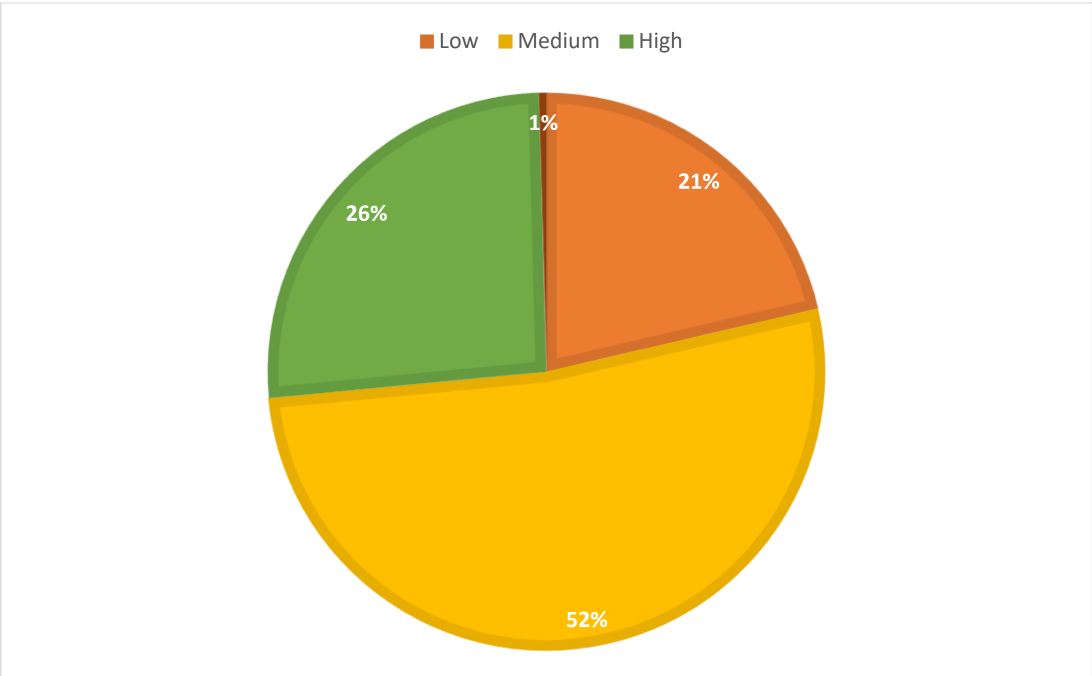


Table 4.2.6

Percentage distribution of different levels of Technological Pedagogical Knowledge.

Technological Pedagogical Knowledge	Count	Percent
Low	57	20.73
Moderate	188	68.36
High	30	10.91
Total	275	100

From the table 4.2.6, it is clear that 20.73% of prospective teachers have low level technological pedagogical knowledge. 68.36% of them have moderate level of technological pedagogical knowledge and 10.91% of them have high level of technological pedagogical knowledge.

Figure 4.6

Percentage of Technological Pedagogical Knowledge

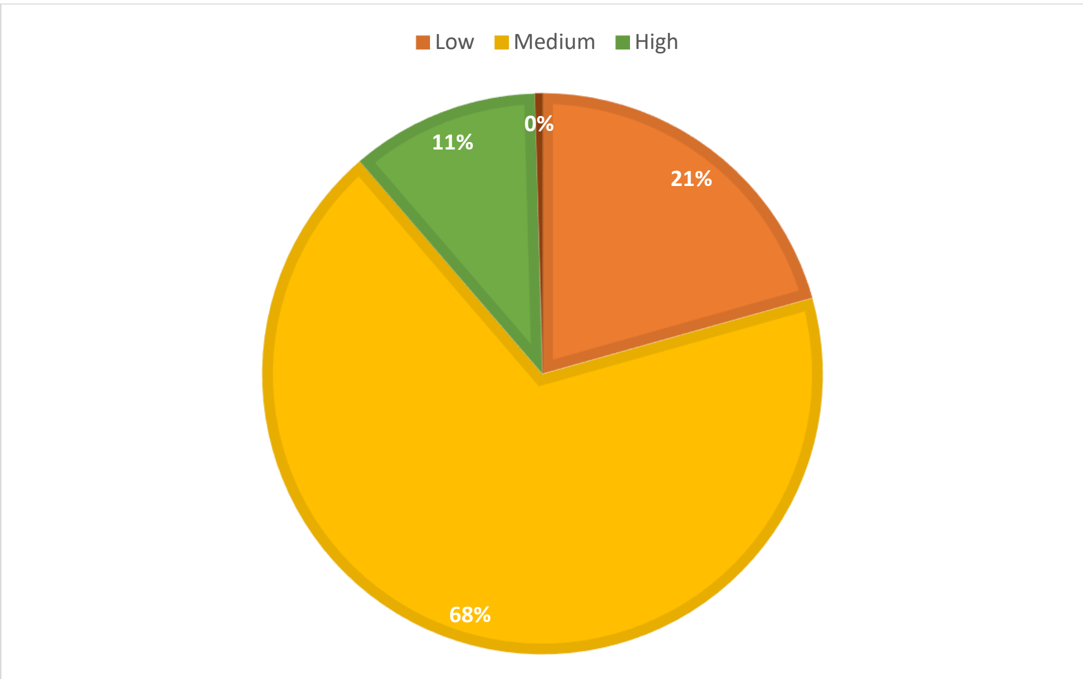


Table 4.2.7

Percentage distribution of different levels of Technological Pedagogical Content Knowledge.

Technological Pedagogical Content Knowledge	Count	Percent
Low	63	22.91
Moderate	212	77.09
High	0	0
Total	275	100

From the table 4.2.7, it is clear that 22.91% of prospective teachers have low level of technological pedagogical content knowledge and 77.09% of them have moderate level of technological pedagogical content knowledge.

Figure 4.7

Percentage of Technological Pedagogical Content Knowledge

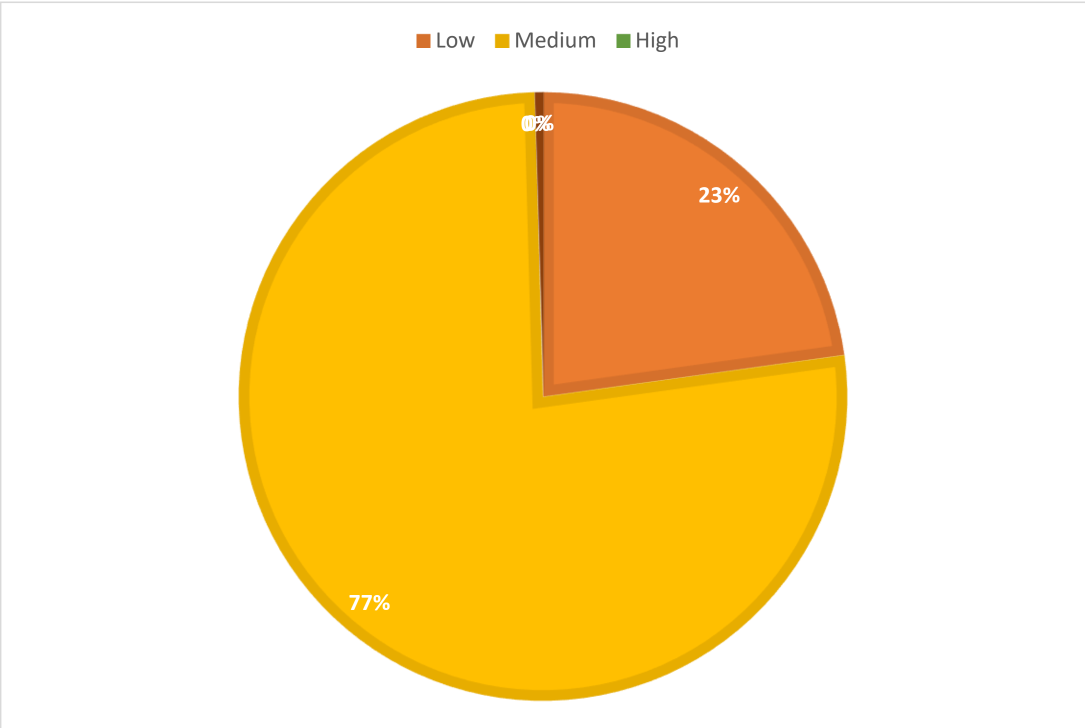


Table 4.2.8

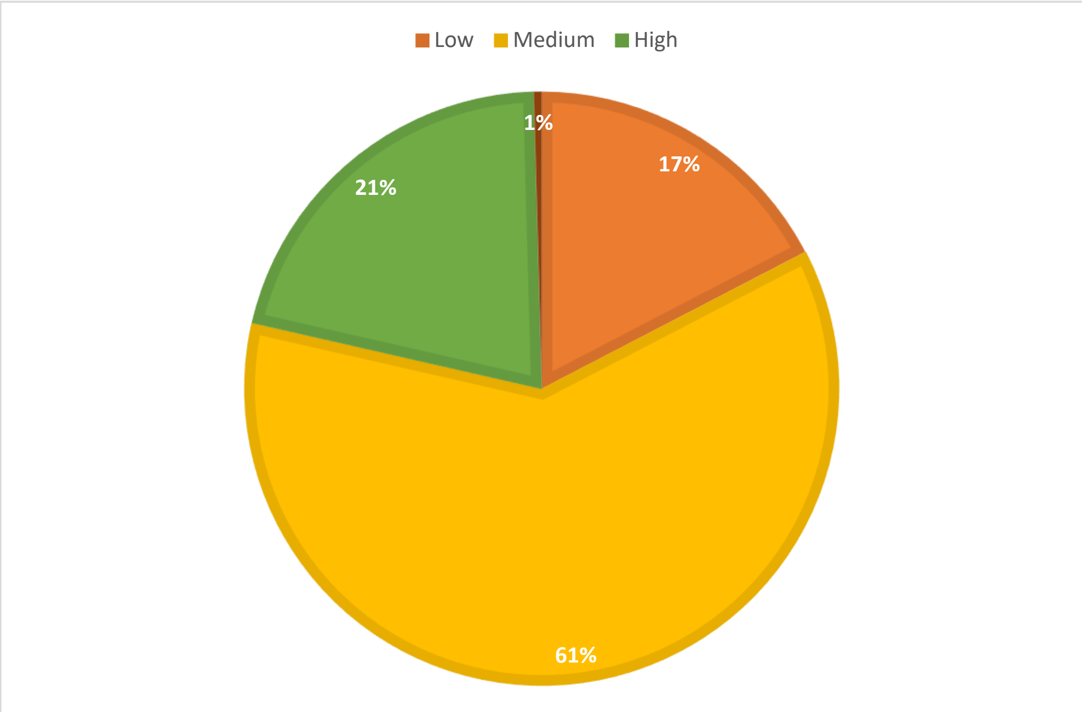
Percentage distribution of different levels of TPACK of Prospective Teachers

TPACK	Count	Percent
Low	48	17.45
Moderate	169	61.45
High	58	21.09
Total	275	100

From the table 4.2.8, it is clear that 17.45 % of prospective teachers have low level in TPACK, 61.45 % of them have moderate level of TPACK and 21.09 % of them have high level of TPACK.

Figure 4.8

Percentage of TPACK of Prospective Teachers



4.3 Differential Analysis

H_0 – 1: There exists no significant difference in the mean scores of technological knowledge of rural and urban prospective teachers of Physical Science.

Table 4.3.1

Comparison of Technological Knowledge of Prospective Teachers based on Locale

	Locale	Mean	SD	N	t	p	Remarks
Technological Knowledge	Rural	7.52	1.50	150	1.043	0.298	NS
	Urban	7.34	1.36	125			

Table 4.3.1, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of technological knowledge of prospective teachers based on locale. Hence the null hypothesis is accepted.

H_0 – 2: There exists no significant difference in the mean scores of pedagogical knowledge of rural and urban prospective teachers of Physical Science.

Table 4.3.2

Comparison of Pedagogical Knowledge of Prospective Teachers based on locale

	Locale	Mean	SD	N	t	p	Remarks
Pedagogical Knowledge	Rural	7.50	1.63	150	1.957	0.051	NS
	Urban	7.86	1.42	125			

Table 4.3.2, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of pedagogical knowledge of prospective teachers based on locale. Hence the null hypothesis is accepted.

H_0 – 3: There exists no significant difference in mean scores of Content Knowledge of rural and urban prospective teachers of Physical Science

Table 4.3.3

Comparison of Content Knowledge of Prospective Teachers based on Locale

	Locale	Mean	SD	N	t	p	Remarks
Content Knowledge	Rural	7.45	1.08	150	0.153	0.879	NS
	Urban	7.43	1.08	125			

Table 4.3.3, shows that p > 0.05 value is not significant at 5% level. So, there is no significant difference in the mean scores of content knowledge of prospective teachers based on locale. Hence the null hypothesis is accepted.

H_0 – 4: There exists no significant difference in the mean scores of pedagogical knowledge of rural and urban prospective teachers of Physical Science.

Table 4.3.4

Comparison of Pedagogical Content Knowledge of Prospective Teachers based on Locale

	Locale	Mean	SD	N	t	p	Remarks
Pedagogical Content Knowledge	Rural	10.81	2.12	150	0.682	0.496	NS
	Urban	10.65	1.77	125			

Table 4.3.4, shows that p > 0.05 value is not significant at 5% level. So, there is no significant difference in the mean scores of pedagogical content knowledge of prospective teachers based on locale. Hence the null hypothesis is accepted.

H_0 – 5: There exists no significant difference in the mean scores of technological content knowledge of rural and urban prospective teachers of Physical Science.

Table 4.3.5

Comparison of Technological Content Knowledge of Prospective teachers based on Locale

	Locale	Mean	SD	N	t	p	Remarks
Technological Content Knowledge	Rural	10.23	2.17	150	0.423	0.673	NS
	Urban	10.35	2.48	125			

Table 4.3.5, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of technological content knowledge of prospective teachers based on locale. Hence the null hypothesis is accepted.

H_0 – 6: There exists no significant difference in mean scores of technological pedagogical knowledge of rural and urban prospective teachers of Physical Science.

Table 4.3.6

Comparison of Technological Pedagogical Knowledge of Prospective teachers based on Locale.

	Locale	Mean	SD	N	t	p	Remarks
Technological Pedagogical Knowledge	Rural	8.07	2.06	150	0.632	0.528	NS
	Urban	8.22	1.87	125			

Table 4.3.6, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of technological pedagogical knowledge of prospective teachers based on locale. Hence the null hypothesis is accepted.

H_0 – 7: There exists no significant difference in the mean scores of technological pedagogical content knowledge of rural and urban prospective teachers of Physical Science.

Table 4.3.7

Comparison of Technological Pedagogical Content Knowledge of Prospective Teachers based on Locale.

	Locale	Mean	SD	N	t	p	Remarks
Technological Pedagogical Content Knowledge	Rural	8.85	4.53	150	1.339	0.182	NS
	Urban	9.54	4.01	125			

Table 4.3.7, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the technological pedagogical content knowledge of prospective teachers based on locale. Hence the null hypothesis is accepted.

H_0 – 8: There exists no significant difference in the mean scores of technological knowledge of graduate and postgraduate prospective teachers of Physical Science.

Table 4.3.8

Comparison of Technological Knowledge of Prospective Teachers based on Qualification.

	Qualification	Mean	SD	N	t	p	Remarks
Technological Knowledge	UG	7.43	1.45	217	0.094	0.925	NS
	PG	7.45	1.43	58			

Table 4.3.8, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of technological knowledge of prospective teachers based on qualification. Hence the null hypothesis is accepted.

H_0 – 9: There exists significant difference in the mean scores of pedagogical knowledge of graduate and postgraduate degree of prospective teachers of Physical Science.

Table 4.3.9

Comparison of Pedagogical Knowledge of Prospective Teachers based on Qualification.

	Qualification	Mean	SD	N	t	p	Remarks
Pedagogical Knowledge	UG	7.56	1.59	217	2.48	0.014	Sig. at 0.05 level
	PG	8.05	1.26	58			

Table 4.3.9, shows that $p < 0.05$ value is significant at 5% level. So, there is significant difference in the mean scores of pedagogical knowledge of prospective teachers based on qualification. Hence the null hypothesis rejected. Prospective teachers with a PG degree possess high pedagogical knowledge than those with a UG degree.

H_0 – 10: There exists significant difference in the mean scores of content knowledge of graduate and Postgraduate degree of prospective teachers of Physical Science.

Table 4.3.10

Comparison of Content Knowledge of Prospective Teachers based on Qualification.

	Qualification	Mean	SD	N	t	p	Remarks
Content Knowledge	UG	7.36	1.11	217	2.589	0.01	Sig. at 0.01 level
	PG	7.72	0.89	58			

Table 4.3.8, shows that $p < 0.01$ value is significant at 1% level. So, there is significant difference in the mean scores of content knowledge of prospective teachers based on qualification. Hence the null hypothesis is rejected. Prospective teachers with a PG degree possess high content knowledge than those with a UG degree.

H_0 – 11: There exists no significant difference in the mean scores of pedagogical content knowledge of graduate and postgraduate prospective teachers of Physical Science.

Table 4.3.11

Comparison of Pedagogical Content Knowledge of Prospective Teachers based on Qualification.

	Qualification	Mean	SD	N	t	p	Remarks
Pedagogical Content Knowledge	UG	10.75	2.03	217	0.227	0.821	NS
	PG	10.69	1.72	58			

Table 4.3.11, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of pedagogical content knowledge of prospective teachers based on qualification. Hence the null hypothesis is accepted.

H_0 – 12: There exists no significant difference in the mean scores of technological content knowledge of graduate and postgraduate prospective teachers of Physical Science.

Table 4.3.12

Comparison of Technological Content Knowledge of Prospective Teachers based on Qualification.

	Qualification	Mean	SD	N	t	p	Remarks
Technological Content Knowledge	UG	10.27	2.27	217	0.252	0.801	NS
	PG	10.36	2.45	58			

Table 4.3.12, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of technological content knowledge of prospective teachers based on qualification. Hence the null hypothesis is accepted.

H_0 – 13: There exists no significant difference in the mean scores of technological pedagogical knowledge of graduate and postgraduate prospective teachers of Physical Science.

Table 4.3.13

Comparison of Technological Pedagogical Knowledge of Prospective Teachers based on Qualification.

	Qualification	Mean	SD	N	t	p	Remarks
Technological Pedagogical Knowledge	UG	8.05	1.94	217	1.396	0.164	NS
	PG	8.47	2.06	58			

Table 4.3.13, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of technological pedagogical knowledge of prospective teachers based on qualification. Hence the null hypothesis is accepted.

H_0 – 14: There exists no significant difference in the mean scores of technological pedagogical content knowledge of graduate and postgraduate prospective teachers of Physical Science.

Table 4.3.14

Comparison of Technological Pedagogical Content Knowledge of Prospective Teachers based on Qualification.

	Qualification	Mean	SD	N	t	p	Remarks
Technological Pedagogical Content Knowledge	UG	8.98	4.42	217	1.509	0.133	NS
	PG	9.86	3.81	58			

Table 4.3.14, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of technological pedagogical content knowledge of prospective teachers based on qualification. Hence the null hypothesis is accepted.

H_0 – 15: There exists no significant difference in the mean scores of technological knowledge among Physical Science prospective teachers specializing in Physics and Chemistry.

Table 4.3.15

Comparison of Technological Knowledge of Prospective Teachers based on Subject specialization.

	Subject specialization	Mean	SD	N	t	p	Remarks
Technological Knowledge	Physics	7.44	1.48	116	0.056	0.955	NS
	Chemistry	7.43	1.41	159			

Table 4.3.15, shows that p > 0.05 value is not significant at 5% level. So, there is no significant difference in the mean scores of technological knowledge of prospective teachers based on subject specialization. Hence the null hypothesis is accepted.

H_0 – 16: There exists significant difference in the mean scores of pedagogical knowledge among Physical Science prospective teachers specializing in Physics and Chemistry.

Table 4.3.16

Comparison of Pedagogical Knowledge of Prospective Teachers based on Subject specialization.

	Subject specialization	Mean	SD	N	t	p	Remarks
Pedagogical Knowledge	Physics	7.41	1.58	116	2.336	0.020	Sig. at 0.05 level
	Chemistry	7.85	1.49	159			

Table 4.3.16, shows that $p < 0.05$ value is significant at 5% level. So, there is significant difference in the mean scores of pedagogical knowledge of prospective teachers based on subject specialization. Hence the null hypothesis is rejected. Prospective teachers specify in Chemistry have high pedagogical knowledge than prospective teachers specify in Physics.

H_0 – 17: There exists no significant difference in the mean scores of content knowledge among Physical Science prospective teachers specializing in Physics and Chemistry.

Table 4.3.17

Comparison of Content Knowledge of Prospective Teachers based on Subject specialization.

	Subject specialization	Mean	SD	N	t	p	Remarks
Content Knowledge	Physics	7.46	1.03	116	0.231	0.818	NS
	Chemistry	7.43	1.11	159			

Table 4.3.17, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of content knowledge of prospective teachers based on subject specialization. Hence the null hypothesis is accepted.

H_0 – 18: There exists no significant difference in the mean scores of pedagogical content knowledge among Physical Science prospective teachers specializing in Physics and Chemistry.

Table 4.3.18

Comparison of Pedagogical Content Knowledge of Prospective Teachers based on Subject specialization.

	Subject specialization	Mean	SD	N	t	p	Remarks
Pedagogical Content Knowledge	Physics	10.86	1.97	116	0.873	0.383	NS
	Chemistry	10.65	1.97	159			

Table 4.3.18, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of pedagogical content knowledge of prospective teachers based on subject specialization. Hence the null hypothesis is accepted.

H_0 – 19: There exists no significant difference in the mean scores of technological content knowledge among Physical Science prospective teachers specializing in Physics and Chemistry.

Table 4.3.19

Comparison of Technological Content Knowledge of Prospective Teachers based on Subject specialization.

	Subject specialization	Mean	SD	N	t	p	Remarks
Technological Content Knowledge	Physics	10.47	2.21	116	1.114	0.266	NS
	Chemistry	10.16	2.37	159			

Table 4.3.19, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of technological content knowledge of prospective teachers based on subject specialization. Hence the null hypothesis is accepted.

H_0 – 20: There exists significant difference in the mean scores of technological pedagogical knowledge among Physical Science prospective teachers specializing in Physics and Chemistry.

Table 4.3.20

Comparison of Technological Pedagogical Knowledge of Prospective Teachers based on Subject specialization.

	Subject specialization	Mean	SD	N	t	p	Remarks
Technological Pedagogical Knowledge	Physics	7.84	1.88	116	2.153	0.032	Sig. at 0.05 level
	Chemistry	8.35	2.02	159			

Table 4.3.20, shows that $p < 0.05$ value is significant at 5% level. So, there is significant difference in the mean scores of technological pedagogical knowledge of prospective teachers based on subject specialization. Hence the null hypothesis is rejected. Prospective teachers specify in Chemistry have high technological pedagogical knowledge than prospective teachers specify in Physics.

H_0 – 21: There exists no significant difference in the mean scores of technological pedagogical content knowledge among Physical Science prospective teachers specializing in Physics and Chemistry.

Table 4.3.21

Comparison of Technological Pedagogical Content Knowledge of Prospective Teachers based on Subject specialization.

Technological Pedagogical Content Knowledge	Subject specialization	Mean	SD	N	t	p	Remarks
	Physics	8.72	4.47	116	1.471	0.142	NS
	Chemistry	9.50	4.16	159			

Table 4.3.21, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of technological pedagogical content knowledge of prospective teachers based on subject specialization. Hence the null hypothesis is accepted.

H_0 – 22: There exists no significant difference in the mean scores of TPACK of rural and urban prospective teachers based on locale.

Table 4.3.22

Comparison of TPACK of Prospective Teachers based on Locale.

Locale	Mean	SD	N	t	p	Remarks
Rural	60.44	7.03	150	1.166	0.244	NS
Urban	61.39	6.46	125			

Table 4.3.22, shows that $p > 0.05$ value is not significant at 5% level. So, there is no significant difference in the mean scores of TPACK of rural and urban prospective teachers based on locale. Hence null hypothesis is accepted.

H_0 – 23: There exists significant difference in the mean scores of TPACK of UG and PG prospective teachers based on qualification.

Table 4.3.23

Comparison of TPACK of Prospective Teachers based on Qualification.

Qualification	Mean	SD	N	t	p	Remarks
UG	60.41	6.97	217	2.461	0.014	Sig. at 0.05 level
PG	62.60	5.74	58			

Table 4.3.23, shows that p < 0.05 value is significant at 5% level. So, there is significant difference in the mean scores of TPACK of UG and PG prospective teachers based on qualification. Hence null hypothesis is rejected. Prospective teachers with a PG degree possess high TPACK than those with a UG degree.

H_0 – 24: There exists no significant difference in the mean scores of TPACK of Physics and Chemistry prospective teachers based on subject specialization.

Table 4.3.24

Comparison of TPACK of Prospective Teachers based on Subject Specialization.

Subject Specialization	Mean	SD	N	t	p	Remarks
Physics	60.20	6.93	116	1.395	0.164	NS
Chemistry	61.39	6.46	125			

Table 4.3.24, shows that p > 0.05 value is not significant at 5% level. So, there is no significant difference in the mean scores of TPACK of Physics and Chemistry prospective teachers based on subject specialization. Hence null hypothesis is accepted.

CHAPTER V

FINDINGS, IMPLICATIONS AND CONCLUSION

5.1 The Study in Retrospect

The study under the investigation is entitled as Technological Pedagogical Content Knowledge of Prospective Teachers. This chapter attempts to summarize all the findings, conclusions and suggestions drawn from the present investigation.

5.2 Objectives of The Study

1. To construct and validate Technological Pedagogical Content Knowledge test.
2. To find the level of Technological Pedagogical Content Knowledge of prospective teachers.
3. To study the significant difference in the mean scores of Technological Pedagogical Content Knowledge of prospective teachers with respect to locale, qualification, subject specialization, computer knowledge.
4. To study the significant difference, if any, in the mean scores of Technological Pedagogical Content Knowledge of prospective teachers in total and with regard to the dimensions namely concept of TK, PK, CK, PCK, TCK, TPK, TPACK.

5.3 Hypotheses Framed for the Study

1. There is no significant difference in the mean scores of Technological Pedagogical Content Knowledge and its dimensions of prospective teachers of rural and urban locale.

2. There is no significant difference in the mean scores of Technological Pedagogical Content Knowledge and its dimensions of prospective teachers with qualification as graduate and postgraduate.
3. There is no significant difference in the mean scores of Technological Pedagogical Content Knowledge and its dimensions of prospective teachers with subject specialization as Physics and Chemistry.

5.4 Methodology in Brief

Normative survey method was adopted for conducting the study. The study was conducted on a sample of 275 prospective teachers of Physical science from various Colleges of Education of Kanniyakumari District in Tamil Nadu using simple random sampling technique. The tool used for the present study was Technological Pedagogical Content Knowledge test constructed and validated by the investigator.

The investigator visited various Colleges of Education in Kanniyakumari District. The TPACK test was administered individually to the prospective teachers of Physical Science. Proper instruction was given by the investigator. Prospective teachers were instructed to read the questions carefully and mark their responses in the response sheet.

Scoring

The investigator prepared a scoring key for correcting the response sheet. Each correct answer was given one mark and for wrong answer zero mark was given. The score of technological pedagogical content knowledge test is the total of the scores obtained for all the items.

Statistical Techniques used

For the analysis of the data following statistical techniques were used.

i. Percentage analysis
ii. t test
iii. ANOVA followed by Scheffee's Post hoc analysis.

5.6 Findings

1. 7.27% of prospective teachers have low level of Technological Knowledge, 60. 73% of them have medium level of Technological Knowledge and 32% of them have high level of Technological Knowledge.
2. 31.27% of prospective teachers have low level of Pedagogical Knowledge, 68.73% of them have medium level of Pedagogical Knowledge.
3. 13.45% of prospective teachers have low level of Content Knowledge, 76.36% of them have medium level of Content Knowledge and 10.19% of them have high level of Content Knowledge.
4. 24% of prospective teachers have low level of Pedagogical Content Knowledge, 56.73% of them have medium level of Pedagogical Content Knowledge and 19.27% of them have high level of Pedagogical Content Knowledge.
5. 21.45% of prospective teachers have low level of Technological Content Knowledge, 52.36% of them have medium level of Technological Content Knowledge and 26.19% of them have high level of Technological Content Knowledge.
6. 20.73% of prospective teachers have low level of Technological Pedagogical Knowledge, 68.36% of them have medium level of Technological Pedagogical

Knowledge and 10.91% of them have high level of Technological Pedagogical Knowledge.

7. 22.91% of prospective teachers have low level of Technological Pedagogical Content Knowledge, 77.09% of them have medium level of Technological Pedagogical Content Knowledge.
8. 17.45 % of prospective teachers have low level of TPACK, 61.45 % of them have medium level TPACK and 21.09 % of them have high level of TPACK.
9. There is no significant difference in the mean scores of Technological Knowledge of prospective teachers based on locale.
10. There is no significant difference in the mean scores of Pedagogical Knowledge of prospective teachers based on locale.
11. There is no significant difference in the mean scores of Content Knowledge of prospective teachers based on locale.
12. There is no significant difference in the mean scores of Pedagogical Content Knowledge of prospective teachers based on locale.
13. There is no significant difference in the mean scores of Technological Content Knowledge of prospective teachers based on locale.
14. There is no significant difference in the mean scores of Technological Pedagogical Knowledge of prospective teachers based on locale.
15. There is no significant difference in the Technological Pedagogical Content Knowledge of prospective teachers based on locale.
16. There is no significant difference in the mean scores of Technological Knowledge of prospective teachers based on qualification.

17. There is significant difference in the mean scores of Pedagogical Knowledge of prospective teachers based on qualification. Prospective teachers with a PG degree possess high pedagogical knowledge than those with a UG degree.
18. There is significant difference in the mean scores of Content Knowledge of prospective teachers based on qualification. Prospective teachers with a PG degree possess high content knowledge than those with a UG degree.
19. There is no significant difference in the mean scores of Pedagogical Content Knowledge of prospective teachers based on qualification.
20. There is no significant difference in the mean scores of Technological Content Knowledge of prospective teachers based on qualification.
21. There is no significant difference in the mean scores of Technological Pedagogical Knowledge of prospective teachers based on qualification.
22. There is no significant difference in the mean scores of Technological Pedagogical Content Knowledge of prospective teachers based on qualification.
23. There is no significant difference in the mean scores of Technological Knowledge of prospective teachers based on subject specialization.
24. There is significant difference in the mean scores of Pedagogical Knowledge of prospective teachers based on subject specialization. Prospective teachers specify in Chemistry have high pedagogical knowledge than prospective teachers specify in Physics.
25. There is no significant difference in the mean scores of Content Knowledge of prospective teachers based on subject specialization.
26. There is no significant difference in the mean scores of Pedagogical Content Knowledge of prospective teachers based on subject specialization.

27. There is no significant difference in the mean scores of Technological Content Knowledge of prospective teachers based on subject specialization.
28. There is significant difference in the mean scores of Technological Pedagogical Knowledge of prospective teachers based on subject specialization. Prospective teachers specify in Chemistry have high technological pedagogical knowledge than prospective teachers specify in Physics.
29. There is no significant difference in the mean scores of technological pedagogical content knowledge of prospective teachers based on subject specialization.

5.7 Educational Implications of The Study

1. Provide opportunities for prospective teachers to explore and use different digital technologies in their teaching practice. Encourage them to explore new ways of using technology to enhance student learning in physical science.
2. Prospective teachers could provide with both theoretical and practical knowledge in using online education. Teacher education colleges could provide ample knowledge to their students about the various aspects of TPACK. The concept of TPACK and its practical orientation should be provided.
3. Encourage prospective teachers to update the advancements in technology and pedagogy related to physical science education.
4. Provide in-service training for TPACK to the teachers in government and aided school.
5. Workshops, conferences, and webinars on TPACK for teacher educators to empower the prospective teachers to understand and integrate technology, pedagogy, and content knowledge.

6. Give more importance on TPACK integration in pedagogy classes for writing lesson plan and teaching learning.
7. Infrastructure and curriculum have to be updated according to the new trends of technology. The government could provide fund for improving the quality of infrastructure such as computer lab with all the technological devices used for teaching learning.
8. Integration of TPACK can improve teacher competence, facilitating active learning, enhancing student engagement, and integrating pedagogical, content, and technological elements in teaching learning processes for effective learning.
9. Integration of technology tools and resources could be used in teaching science concepts.
10. Different technology integration like flipped learning, online resources, OER, web-based learning, and teaching methods like co-operative learning, models of teaching, content knowledge can improve teachers’ deep understanding of subject pedagogy.

5.8 Suggestion For Further Research

In the light of the present study and its results, it is suggested to undertake the following studies in the future.

1. The study has been taken up with B.Ed. prospective teachers in Kanniyakumari District only; similar studies can be conducted with all colleges of Education in Tamil Nadu.
2. TPACK of teachers from Arts and Science college and other type of colleges could be studied.
3. Teaching Competency and TPACK of prospective teachers and teachers.
4. Attitude of the prospective teachers or teachers or teacher educators toward TPACK integration in teaching.
5. Techno stress and TPACK among the prospective teachers and teacher educators.
6. A relationship between Self-efficacy and TPACK of prospective teachers and teachers.
7. Impact of Virtual reality on TPACK of prospective teachers.
8. Effectiveness of online teaching integrating with TPACK of prospective teachers and teachers teaching.
9. Effectiveness of Gamification on TPACK of prospective teachers and teachers.
10. Technological Pedagogical Content Knowledge of teachers of teaching Science and attitude toward integration of TPACK.
11. Effectiveness of Augmented Reality integrated with TPACK and teaching competency of prospective teachers.

5.9 Conclusion

Technological Pedagogical Content Knowledge of prospective teachers is moderate. The findings revealed that there is significant difference in the mean scores of Pedagogical Knowledge of prospective teachers based on qualification. There is significant difference in the mean scores of Content Knowledge of prospective teachers based on qualification. There is significant difference in the mean scores of Pedagogical Knowledge of prospective teachers based on subject specialization. There is significant difference in the mean scores of Technological Pedagogical Knowledge of prospective teachers based on subject specialization. Technological Pedagogical Content Knowledge is an understanding that emerges from interactions among content, pedagogy, and technology knowledge. The TPACK model suggests the perfect combination of pedagogy, content and technology integrate in teaching emphasized for prospective teachers to provide the most rounded educational experience. TPACK development within a teacher preparation program is no doubt a complex endeavour where students may need to experience a range of learning opportunities to maximize their growth. The NEP 2020 has emphasized teachers' professional development in the context of the use of the latest technologies and pedagogical strategies for teaching a particular content in an effective manner.

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