Planning Instruction:

Introduction:

Process of making such plans to achieve some goal or objective is called "Planning"

Planning commonly refers to the time teachers spend preparing and designing activities for Students. From tasks and activities to instructional practices employed during lessons, teachers need to consider a variety of aspects of their instruction before students even enter the classroom.

Teachers need to pay careful attention to designing their lessons; "effective teachers understand that teaching requires a considerable effort at design. Such design is often termed planning, which many teachers think of as a core routine of teaching."

Reviews of teacher planning and decision-making further emphasize the centrality of planning processes in teachers' practice. Teachers first consider the learning activities that take into account students' interests and abilities, then the learning goals and objectives of the lesson, and finally the evaluation procedures to be used during the lesson.

Definition of "Planning Instruction"

A teacher must be able to plan and manage instruction based upon knowledge of subject matter, students, the community, and curriculum goals. Well-planned instruction that is aligned to the content standards and needs of the students is a teacher's most powerful tool to engage students, manage the classroom, and improve student learning.

Instructional planning always starts with the goals:

- What content must be learned?
- What skills must be developed?
- What themes and concepts must students understand?

Using these as a baseline, the best teachers will next identify areas of strength and weakness of incoming students, determine the interests of the class, and modify or develop new learning experiences that fit the needs of the group. In class each day, a well-prepared teacher has a tentative schedule and a set of alternative ideas that provide an opportunity to adapt in real time as needed.

Need of planning instruction:

1. Teachers need to consider the mathematical content and ways to engage students in discussion about the content, while simultaneously guiding students towards a particular goal. For example, during planning and instruction teachers modify tasks and ask high-level questions in order to promote students' understanding of the underlying ideas and concepts.
2. To support students' understanding, teachers needa variety of pedagogical skills. For example, teachers need to be able to resist the urge to tell students how to work on the content so that they provide students with adequate time to think through what they are asked to do.
3. Teachers need to make important and often simultaneous decisions in ways that do not undermine students' thinking or the mathematical opportunities afforded by the content in reform curricula. Hereafter, "problems" will be used to refer to the challenges and decisions teachers face during mathematics teaching
4. Teachers must identify a particular mathematical topic to discuss and the means necessary to cover that topic, without necessarily delineating the precise steps needed to teach that topic. Therefore, planning for reform oriented instruction requires teachers to select specific topics or concepts and to identify particular activities, instructional strategies, and suitable materials for discussing and engaging students with the topics or concepts.
5. Teachers need to plan for engaging in this sort of work during instruction. For example, teachers must plan questions they will ask students that will guide students' thinking about the content without giving them too much information, while also encouraging students to explain their ideas.
6. Teachers need to anticipate different solutions students may offer, as well as alternative ways of thinking about a task, in order to facilitate students' learning and discussion of these strategies in ways that foster a shared understanding of the ideas.
7. Teachers also need to anticipate potential errors in order to respond appropriately and help students learn from incorrect solutions.

8. Teachers need to carefully plan their lessons and anticipate how students will interact with the content during implementation in order to further students' understanding of different mathematical ideas.
9. Teacher may need to determine how to incorporate opportunities for students to practice the application of certain skills and procedures within a curriculum the teacher perceives as deficient.
10. Provides students with sufficient opportunities to practice basic skills and procedures, and therefore modifies the lesson suggestions as needed when planning.

Important of planning instruction:

1. Planning is an important and often underappreciated aspect of teaching practice, when teachers make decisions that ultimately impact students' opportunities to learn. Planning commonly refers to the time teachers spend preparing and designing activities for students.
2. The challenges of planning lessons using such curricula may be somewhat different from the challenges of planning lessons with more conventional mathematics curricula. Thus, exploring how teachers plan in the particular context of reform curricula is critical if mathematics educators want to understand this important phase of teaching.
3. Discovery of mathematical ideas through tasks encourages students to make connections between topics and important mathematical ideas in order to help them apply their learning to real-world contexts.
4. Teachers' conceptions of mathematics content are also important for understanding how teachers engage with the curriculum. It is important to understand the extent to which teachers' conceptions of mathematics teaching and learning align with the ideas about teaching and learning underlying the curriculum.
5. Teachers need to make important and often simultaneous decisions in ways that do not undermine students' thinking or the mathematical opportunities afforded by the content in reform curricula.

6. Important concept for students to know and to be able to do. This modification reflected their conceptions about what they considered to be the most important aspects of the content.
7. The teacher's guide's includes summaries of the mathematical content, specific questions to ask students throughout a lesson, and examples of student errors.
8. To understand planning problems, how these problems change over time, and under what conditions they change highlights important elements in mathematics teachers' planning processes.
9. Teachers' planning are essential to consider when developing a new planning model, it is also important to consider the demands and characteristics of the particular discipline in which such planning occurs.
10. **Planning** problems refer to the considerations and decisions teachers face when both **planning** for and anticipating what will happen during a specific lesson. There are several elements that a model of teacher **planning** in the specific context of reform-oriented **mathematics instruction** must capture.

Decision-making

The process followed for identifying and choosing a course of action in order to solve a specific problem is known as decision making. Decision making involves three aspects of human behaviour:

1) Cognition - i.e. activities of the mind associated with knowledge.
2) Conation - i.e. the action of mind implied by such words as willingness, **desire** and / aversion.
3) Affectation - i.e. the aspect of mind associated with emotion, feeling, mood and temperament.

Decision-making could be considered as a **mental (cognitive)** process which results in practical choosing among varied options. Each decision-making process ends in a final choice. The output is weather an action or an idea.

Decision-making, from mind's point of view **(conation)**, a problem reveals when a **desired** situation is formed which is different from the current situation. First, the individual tries to achieve the ideal situation via manipulating the current situation in her/his mind, and then, eagers to change the surrounding environment to achieve her/his desired goals

Decision-making is a problem-solving process which ends when a satisfying solution is reached. Therefore, decision making could be considered as an argumentative or **emotional** process which could be (ir) rationally based on implicit/explicit assumptions. In general, decision-making is a mental process that all humankinds are involved in throughout their lives. The process of decision-making is done on the bases of culture, perceptions, belief systems, values, attitudes, personality, knowledge, and the insight of the decider(s).

Decision-making is a process in the brain which takes responsibility of monitoring planning, cognitive flexibility, abstract thinking, role acquisition, initiation of proper action, inhibition of inappropriate actions, and helps attentional processes in order to select related sensory information

Decision-making, according to rational, logical and principal bases, is an important part of all scientific decisions and specialists are trying to present their knowledge to domains in which decisions are structured.

Definition of Decision-making

- Decision-making is the process of identifying a set of feasible alternatives and choosing a course of action from them. Decision-making is a part of planning.
- Decision-making is an intermediate-sized set of activities that begins with an identifying problem and ends with choice making or decision giving.
- **Decision-making** is defined as the **process** by which different possible solutions or alter natives are identified and the most feasible solution or course of action is finalized. It is an **integral part of planning**. **Decision-making** results in selecting the right action among different available options.

Factors involved in decision-making

In controlled environments, such as classrooms, instructors may try to persuade students to weigh cons and pros before deciding. This strategy is called Franklin's rule. However, with respect to the need of enough time, cognitive resources, and a full access to related information about decision subject, this rule is not able to describe deciding mechanisms of individuals, well

In a general manner, the influencing factors on decision-making could be classified as follows

1. **Rational factors**: quantitative factors such as price, time, predictions, etc. People usually tend to consider such factors and forget non-quantitative ones.
2. **Psychological factors**: Human participation in decision-making is obvious. Factors such as personality of the decider, her/hic capabilities, experiences, perceptions, values, goals, and roles are important factors in decision-making.
3. **Social factors**: Others' agreement, especially those who influence decider, is a matter of importance. Considering these issues reduces others' resistance against the decision.
4. **Cultural factors**: Surrounding environment has varied layers which are called culture of the region, culture of the country, and culture of the universe. Also, the culture of the decider's organization should be also considered. These cultures influence individual/organization decisions in the form of socially accepted values, trends, and common values.

Planning in decision-making

It shall be noted that decision-making is part of a higher cortical function and one of most brilliant representations of individual and collective cognitive functions. Therefore, decision-making must have methods, so that the best and most accurate results are achieved for individual/organization. This is because the decisions can have vital and determinative roles in future and can be the next steps of the individual/organization's life. One of the major components of decision-making is planning. Decision-making without planning is common, though would not end up in good results. Planning for

decisions can be taken in a simple and intellectual manner. Planning makes decision-making easier than it appears.

Benefits of planning in decision-making could be classified in four groups:

1. Planning can help the development of independent goals. In fact, planning consists of conscious and guided sequences of choices.
2. Planning provides some standards for measurement. Planning could be considered as a scale of how individual/organization progresses in line of determined goals.
3. Planning transforms values to actions. Individuals/organizations think about their plan and design and decide what can help them advance their programs, twice as much.
4. Planning helps to devote limited resources effectively and in a systematic hierarchy. In general, planning helps individuals/organizations to better manage their limited resources in all situations.

Relation between Planning and Decision-Making

Both planning and decision-making are connected to each other. These are the most important aspects of management functions. Planning requires a series of decisions to be incorporated in advance. The foundation of planning is decision-making. The role of a planner demands good decision-making abilities also as the planner has to take a lot of decisions simultaneously. So, decision-making is an important task in planning. Simultaneous and a number of decisions make a plan. In the absence of decision-making, it's not possible to answer what, how, when, and who is planning. To execute planned activities, decision-making is compulsory.

Decisions can be made without planning but planning cannot be done without making decisions. Planning can be defined as the process of selecting a future course of action. Decision-making defined as the process of selecting a course of action from the alternatives.

So, planning has an important role to play in decision-making.

Pedagogical content knowledge

Meaning:

Pedagogical content knowledge is a type of knowledge that is unique to teachers, and is based on the manner in which teachers relate their pedagogical knowledge (what they know about teaching) to their subject matter knowledge (what they know about what they teach). It is the integration or the synthesis of teachers' pedagogical knowledge and their subject matter knowledge that comprises pedagogical content knowledge. According to Shulman (1986) pedagogical content knowledge

. . . embodies the aspects of content most germane to its teachability. Within the category of pedagogical content knowledge include, for the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations - in a word, the ways of representing and formulating the subject that make it comprehensible to others . . . [It] also includes an understanding of what makes the learning of specific concepts easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning (p. 9)

Definitions

Pedagogical content knowledge is a special combination of content and pedagogy that is uniquely constructed by teachers and thus is the “special” form of an educator’s professional knowing and understanding.

Pedagogical content knowledge also is known as craft knowledge. It comprises integrated knowledge representing teachers’ accumulated wisdom with respect to their teaching practice: pedagogy, students, subject matter, and the curriculum.

Pedagogical content knowledge must be addressed within the context of a diverse pedagogy.

Shulman defined pedagogical content knowledge as teachers’ interpretations and transformations of subject-matter knowledge in the context of facilitating student learning. He further proposed several key **elements of pedagogical content knowledge**:

(1) knowledge of representations of subject matter (content knowledge);

(2) understanding of students' conceptions of the subject and the learning and teaching implications that were associated with the specific subject matter; and

(3) general pedagogical knowledge (or teaching strategies).

To complete what he called **the knowledge base for teaching**, he included other elements:

(4) curriculum knowledge;

(5) knowledge of educational contexts; and

(6) knowledge of the purposes of education (Shulman, 1987).

To this conception of pedagogical content knowledge, others have contributed valuable insights on the importance and relevance of the linguistic and cultural characteristics of a diverse student population.

Components of pedagogical content knowledge

A model of pedagogical content knowledge that results from an integration of *four* major components,

- Two of which are subject matter knowledge and pedagogical knowledge.
- The other two other components of teacher knowledge also differentiate teachers from subject matter experts.

One component is **teachers' knowledge of students' abilities and learning strategies, ages and developmental levels, attitudes, motivations, and prior knowledge of the concepts to be taught.** Students' prior knowledge has been especially visible in the last decade due to literally hundreds of studies on student misconceptions in science and mathematics.

The other component of teacher knowledge that contributes to pedagogical content knowledge is **teachers' understanding of the social, political, cultural and physical environments in which students are asked to learn.**

RECOMMENDATIONS FOR TEACHERS

1. The first recommendation that **can be made for teachers is for them to begin to more often reflect on or think about *why* they teach specific ideas the way they do**. Teachers know much more about teaching subject matter concepts to students than they are aware. This is pedagogical content knowledge; and many teachers don't think about this knowledge as important. It is important, though, because it determines what a teacher does from minute to minute in the classroom, as well as influencing long term planning.

   To become more aware of this knowledge and to be able to more clearly think about it, teachers can find ways to keep track of this information, just as they ask students to do with the data collected in lab assignments. One way is to keep a personal notebook describing their teaching, even just once a week or so for a few difficult concepts. Another strategy is to videotape or audiotape a few class periods just to help see what's happening in the classroom. (It's not necessary to have anyone but the teacher sees or listens to the tape.) Then teachers can start to think about the following types of questions. Which ideas need the most explanation? Why are those ideas more difficult for the students? What examples, demonstrations, and analogies seemed to work the best? Why did they work or not work? Which *students* did they work best *for*?
2. **Teachers can try new ways of exploring how the students are thinking about the concepts being taught.** Ask students about how and what they understand (not in the sense of a test, but in the sense of an interview). Ask students what "real life" personal situations they think science relates to. Try to get inside their heads and see the ideas from their point of view.
3. **Start discussions with other teachers about teaching**. Take the time to find someone you can share ideas with and take the time to learn to trust each other. **Exchange strategies for teaching difficult concepts or dealing with specific types of students.** Get involved in a peer coaching project in your school or district. District faculty development staff or people at a local university can help

you get one started and may be able to provide substitute support. Ask about telephone hot-lines and computer networks for teachers, and explore the **World Wide Web**.

4. **Get involved in action research projects. Much of the newest and most important research is being conducted by teachers**. Take a class at your nearest university and find out what is going on. Get involved with a mentor teacher program or a teacher on special assignment program. Join organizations and go to conferences such as the national or regional National Science Teachers Association or the NARST meetings. There are also often summer workshops and institutes in specific fields in science at many universities and colleges.

How PCK is Developed

- Pedagogical content knowledge is deeply rooted in a teacher's everyday work. However, it is not opposite to theoretical knowledge. It encompasses both theory learned during teacher preparation as well as experiences gained from ongoing schooling activities.
- The development of pedagogical content knowledge is influenced by factors related to the teacher's personal background and by the context in which he or she works.
- Pedagogical content knowledge is deeply rooted in the experiences and assets of students, their families and communities.

Impact of PCK

- When teaching subject matter, teachers' actions will be determined to a large extent by the depth of their pedagogical content knowledge, making this an essential component of their ongoing learning.
- Pedagogical content knowledge research links knowledge on teaching with knowledge about learning, a powerful knowledge base on which to build teaching expertise.

Mathematics "Content Knowledge" and "Pedagogical Content Knowledge"

Teachers' knowledge is a key factor to students' academic success in today's classrooms. There have been many debates on the underlying interpretation of what Mathematics teacher's knowledge includes Mathematics content knowledge or Mathematics pedagogical content knowledge or both.

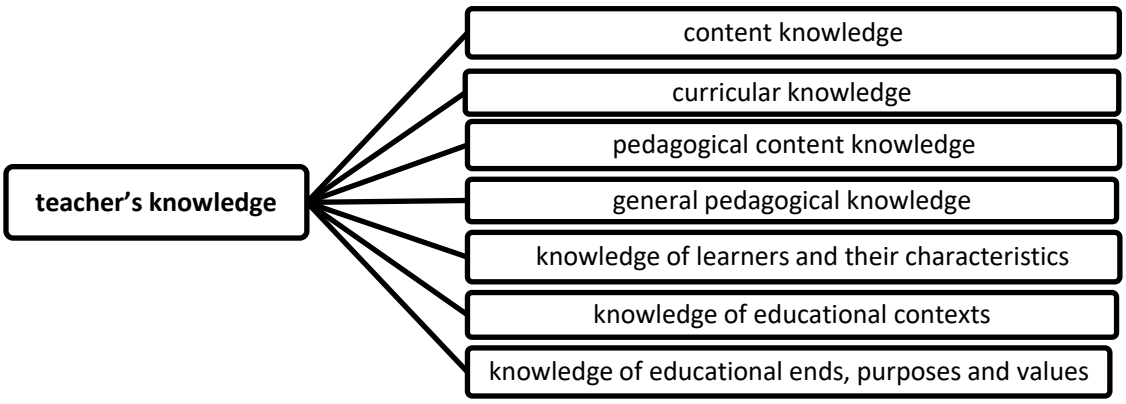
What is the difference or relation between these two?

In the 1980's, Lee Shulman and his colleagues popularized the concept of "pedagogical content knowledge" and introduced a new way of thinking about the nature and role of the teacher's knowledge needed for high academic success of students Shulman (1986).

In 1987, Shulman distinguished **teacher's knowledge in seven categories**: **content knowledge; curricular knowledge; pedagogical content knowledge; general pedagogical knowledge; knowledge of learners and their characteristics; knowledge of educational contexts and knowledge of educational ends, purposes and values.**

Ever since Shulman established these categories, many researchers have come to believe that pedagogical content knowledge is an important topic in Mathematics education and that high levels of pedagogical content knowledge will predict high levels of student achievement and this believe has further grounded the platform for discussion to which one is most important content knowledge or pedagogical content knowledge.

Figure1: Shulman's Seven Categories of Teacher's Knowledge



Ball's studies (1990) showed that effective Mathematics teaching is linked to both teachers' subject matter content knowledge as well as their pedagogical content knowledge. Heid et al. (1999) showed that secondary Mathematics' teachers content knowledge influences their instructional planning and classroom practice. Heather et al. (2005) found that teachers' mathematical knowledge was significantly related to student achievement. Waller (2012) found positive relationship of Mathematics intervention teachers' pedagogical content knowledge and students' math achievement gains in primary math interventions.

The above-mentioned studies show a significant relation between Mathematics content knowledge, Mathematics pedagogical content knowledge, effective Mathematics teaching and students' math achievement. Before reaching to any conclusion, one must have a deeper insight to both of these terms Mathematics content knowledge, Mathematics pedagogical content knowledge.

Mathematics content knowledge is common knowledge of mathematical content. It is the subject matter knowledge and refers to general Mathematics ability. It includes knowledge about axioms, postulates, theorems, rules, principles, formulae, language, concepts, sub-concepts etc. of Mathematics, depth, breadth, accuracy and application of content knowledge; connections within and between topics and the branches of Mathematics and fluency with multiple modes of examples of a topic and getting solution to a particular mathematical problems.

On the other hand, **Mathematics pedagogical content knowledge** is defined as the specialized content knowledge required for teaching Mathematics. It includes, "the most useful forms of representation …, the most powerful analogies, illustrations, examples, explanations, and demonstrations - in a word, the most useful ways of representing and formulating the subject that make it comprehensible to others…. Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult" (Shulman,1986).

Pedagogical content knowledge is the knowledge of how to transform formal content knowledge into meaningful learning outcomes for students and it involves an understanding of a particular topic and the ways a teacher explains the topic or concepts to make sense to the students in the classroom. Teachers are always expected to exhibit a basic set of pedagogical knowledge and skills in the classroom, which involves a good knowledge of Mathematics, teaching methods, skills and knowledge of child development etc. This is emphasized by (Hill et al 2004) that "In performing the process of teaching and learning, teachers bring alone with them the knowledge components, contents knowledge, good knowledge about the students and the various ways of using content knowledge in a classroom's teaching and learning process indeed play a role". Moreover, the integration of all these knowledge is recognized as pedagogical content knowledge.

For an example, teachers of Mathematics need a special type of understanding of mathematical content itself. "A powerful characteristic of Mathematics is its capacity to compress information into abstract and highly usable forms. . . . Mathematicians rely on this compression in their work. However, teachers work with Mathematics as it is being learned, which requires a kind of decompression or 'unpacking' of ideas" (Ball and Bass, 2003). This "unpacked" knowledge may provide the foundation for knowing how to represent the subject to students or how to understand the mathematical features of student work. Most adults, for example, know that one can "invert and multiply" to get the correct answer to the problem: 3/4 divided by 1/2. However, Mathematics teachers must know why such rules work and how to represent the Mathematics to facilitate student understanding. Is a student mathematically correct in saying that this problem can be illustrated by splitting 3/4 pies evenly between two families or in saying that this can be illustrated by calculating how much money you would have if you doubled Rs.0.75? If not correct, then what is a good story problem that illustrates 3/4 divided by 1/2? Good Mathematics teachers know how to address such questions and how to unpack and represent fractions in ways that are useful in teaching the subject.

Pedagogical content knowledge includes "…understanding of how particular topics, problems, or issues are organized, presented, and adapted to the diverse interests and abilities of learners" and the "…most useful forms of representation of these ideas, most powerful analogies, illustrations, examples, explanations, and demonstrations" and "…the ways of representing and formulating the subject that make it comprehensible to others" (Shulman, 1987).

The relation and difference between the Mathematics content knowledge and pedagogical content knowledge can be better understood from the following table:

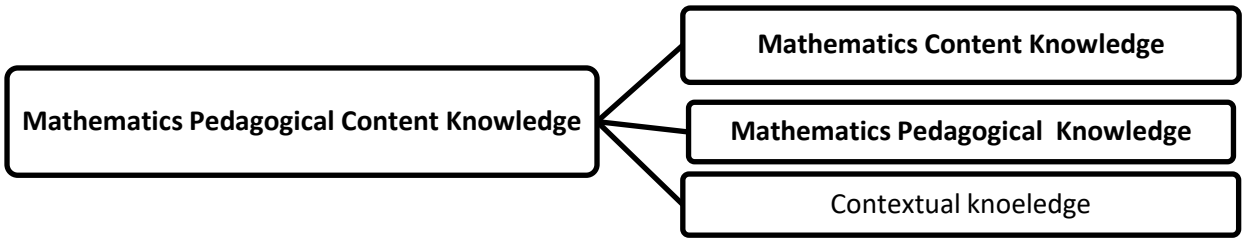
Dimensions of Knowledge	**Mathematics Content Knowledge**	**Mathematics Pedagogical Content Knowledge**
Field of Knowledge	mathematics	Mathematics education
Output of Knowledge	Enables to be skilled and competent Mathematics student/s	Enables to be skilled and competent Mathematics teacher/s
Knowledge is mastered by	The learner/student	teacher
Objective of getting Knowledge	To master the rules, principles, formulae etc. of Mathematics to solve the problems based on them	To transform mathematical knowledge into meaningful learning outcomes for students to make them understand the rules, principles, formulae etc. of Mathematics
Basic Requirements for Knowledge	-The will to learn Mathematics - Attitude towards learning Mathematics	-The will to teach Mathematics -Aptitude for teaching Mathematics
Areas of Study of Knowledge	-The concepts and sub-concepts of Mathematics -The relation within and between	.Teaching of Mathematics · The content knowledge · Content analysis

	the branches of Mathematics -Solution of Mathematical problems related to the concepts of arithmetic, algebra geometry, statistics, trigonometry etc	· Pedagogical analysis ·Psychology of teaching and learning .Learner and her/his characteristics · Methods of evaluation etc.
Knowledge is Mastered Through	Drill work techniques and practice while learning	Training and practice during teaching
Basis for Knowledge	Pure Mathematics and Sciences	Behavioural Sciences
Relation	Without pedagogical content knowledge a teacher will not be teach effectively in the class. Less effective teaching results in less effective content knowledge	Without mastery of content knowledge, teacher cannot master the pedagogical content knowledge.

From the above table it is clear that there is difference between to master the concept her/himself and to make others master the content. The first one refers to the content knowledge and the second one refers to the pedagogical content knowledge. To make students master the Mathematics content knowledge the teacher her/himself has to master the Mathematics content knowledge along with Mathematics pedagogical knowledge and contextual knowledge. Mathematics pedagogical knowledge is "the knowledge or the study of science of teaching mathematical concepts and sub-concepts that influences the Mathematics learning in students". Therefore we can conclude that **Mathematics pedagogical content knowledge includes three sub-components:**

- Mathematics content knowledge –Knowledge of the contents of Mathematics,
- pedagogical knowledge - knowledge of science of teaching, content analysis, pedagogical analysis, methods and techniques of presentation and

- Contextual knowledge - the level, characteristics and needs of the students as well as the subject, teaching-learning environment.



Conclusion:

A teacher with good mathematical pedagogical content knowledge can break down mathematical content knowledge into less polished and abstract forms, thus making it accessible to students who are at different cognitive levels. She/he can unpack the Mathematics into its discrete elements and can explain a concept or procedure at a level that includes the steps necessary for the students to make sense of the reasoning. She/he can understand where students may have trouble learning the subject and will be able to represent mathematical concepts in a way that their students can comprehend its structure and avoid these difficulties. In order to prepare effective Mathematics teachers, a teacher-training program must focus on Mathematics pedagogical content knowledge.