CHAPTER 2
Theoretical Framework of the Study
### Chapter 2: Theoretical Framework of the Study

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“A good TEACHER takes a hand,

Opens a mind and touches one heart”.

The effective teaching learning process follows Bloom’s Taxonomy: Cognitive, Affective and Psychomotor and in terms of student’s behavioral organ- It is Mind, Heart and Hand (Figure 2.1). So a teacher will be effective and superior in teaching when the “TEACHER takes a hand, opens a mind and touches one heart”.

Figure 2.1: Bloom’s Taxonomy: Cognitive, Affective and Psychomotor in terms of student’s behavioral organ- Mind, Heart and Hand

Actually what is the function of a teacher in the society? A teacher mould of constructs value based socially useful productive citizen who finally serve the society in all respect. For this he has to know the learner very well or
every aspect of the learner—his age, mental status, attitude, interests, previous experiences, readiness, social position (Whom factor) and only then the teacher will be able to take a hand, open a mind and touch one heart. Then teacher have to know the Content (What to teach?). After Content Knowledge teacher need to have the knowledge of Pedagogy i.e. process of teaching-learning, so that teacher can understand which content should be taught following which teaching method. With the establishment of different learning theories viz. behaviouristic, cognitive and constructivist learning theory, the teaching process changed abruptly from chalk and talk to activity based or teacher centered to the more learners centered. Shulmans’ had made a framework combining these two knowledge components as PCK or Pedagogical Content Knowledge (How factor?). For meaningful comprehension Integration of technology in the classroom is a prime requirement in the present technological era. So the Knowledge of Technology is also important for teacher (Why factor?).

TPK is termed as Techno-Pedagogical Knowledge. What is Techno-Pedagogy? Techno-pedagogy is “Electronically mediated courses that integrate sound pedagogic principles of teaching/learning with the use of technology”. Koehler & Mishra, in the 2009 added another component ‘Technology’ to the Shulmans’ framework and termed TPACK or Techno-Pedagogical Content Knowledge.
Figure 2.2: Flow Chart TPACK or techno-pedagogical content knowledge.

But only knowledge is not adequate to integrate technology meaningfully in the classroom. For this teacher need to acquire the competency on the techno-pedagogy to execute and achieve better in the teaching learning situations. The competency in the Techno-Pedagogy means ability to utilize technology i.e. integrate and synchronize technology in the classroom. Thus this competency in the Techno-Pedagogy decides when and where to utilize technology (Figure 2.2). The Knowledge and Competency of techno-pedagogy of teachers directly related to the quality of education (Çoklar, A. N. and Özbek, A. 2017).

Nowadays the Information Communication Technology (ICT) is very much improved and wide spread media component with the help of computer
based multimedia technology. Hence, compilation of computer based multimedia teaching aids is very much important in the chemistry teaching learning process for enhanced comprehension of the abstract chemical concepts (Figure 2.3).

![Figure 2.3: Evolution of ICT to IMC](image)

For meaningful integration of technology in the class room Blended teaching-learning is an effective approach. It may be again categorized as: 1) Synchronous learning and 2) Asynchronous learning

2.1. **Synchronous learning**

Synchronous learning refers to a form of education, learning or instruction in which the student learns from the instructor in real time but not necessarily in person or in the same place. The most basic example of synchronous learning is the classroom environment, but now e-learning alternatives have become available. So, the traditional method of teaching and learning is synchronous and typically involves the employment of a classroom where teacher and students interact within the same time and space. E-learning is often done via a teleconference or video conference over a network.
such as the Internet, where teacher and students interact within the same time but not same space. Again the synchronous learning can take the form of one-on-one tutorials and even online seminars, often called webinars.

**Figure 2.4:** Schematic of Synchronous learning

In an online classroom environment many of the learning activities and expectations are similar to those found in a traditional classroom. These learning environments offer meaningful interactions in a face-to-face setting and are most commonly referred to as synchronous learning activities (Harris et al., 2009; Simonson et al., 2012). Lectures, discussions, and lesson presentations occur at a specific point in time with the expectation that all students will be available to participate. Synchronous learning environments support learning and teaching and offer students and teachers with multiple ways of interacting, sharing, and the ability to collaborate and ask questions in real-time through synchronous learning technologies. Examples of
synchronous online technology types include videoconferencing, webcasts, interactive learning models, and telephone conferences (Er et al., 2009).

2.2. Asynchronous learning

Asynchronous learning is a student-centered teaching method that uses online learning resources to facilitate information sharing outside the constraints of time and place among a network of people (Mayadas, F., 1997). Asynchronous learning is based on constructivist theory, a student-centered approach that emphasizes the importance of peer-to-peer interactions (Wu, D., Bieber, M. and Hiltz, S., 2008). This approach combines self-study with asynchronous interactions to promote learning, and it can be used to facilitate learning in traditional on-campus education, distance education, and continuing education. This combined network of learners and the electronic network in which they communicate are referred to as an asynchronous learning network (Figure 2.5).

In an asynchronous learning environment students are able to actively participate in their own learning, giving them the opportunity to interact with their peers, provide peer feedback, and reflect on the status of their personal learning goals and outcomes (Er et al., 2009; Harris et al., 2009; Simonson et al., 2012). In many learning environments there are learning activities and expectations that require students to create, synthesize, explain, and apply the content or skills being taught (Harris, Mishra, & Koehler, 2009; Simonson et
al., 2012). Asynchronous technologies support learning and allow more time for student reflection, collaboration, and student-to-student interactions (Bonk & Zhang, 2006; Skylar, 2009; Meloni, 2010).

**Figure 2.5:** Schematic of Asynchronous learning

### 2.3. Blended Learning Approach

Blended learning approach is an education program (formal or informal) that combines online digital media with traditional classroom methods. It requires the physical presence of both teacher and student, with some element of student control over time, place, path, or pace (Kitchenham, A. 2011). The main five Models of Blended Learning are as follows:

**2.3.1. Face-to-Face Driver Model:** Of all the blended learning models, face-to-face driver is the closest to a typical traditional classroom structure. With this approach, the introduction of online instruction is
decided on a case-by-case basis, meaning only certain students in a given class will participate in any form of blended learning. The face-to-face driver approach allows students who are struggling or working above their grade level to progress at their own pace using technology in the classroom.

2.3.2. Rotation Model: In this form of blended learning, students rotate between different stations on a fixed schedule – either working online or spending face-to-face time with the teacher. When in a course or subject where students rotate on a fixed schedule or at teacher’s discretion between modalities and at least one of which is online are called station rotation. Other modalities might include activities such as small group or full class instruction, group projects, individual tutoring, and pencil-paper assignments. All the activities contained in a classroom. When students were rotated between a computer laboratory and classroom for other activities such as full class instruction, group discussion, projects etc. then the model is termed as Lab Rotation. In Flipped Classroom students were delivered content and instruction through online learning off site in place of traditional homework and then attend the brick and mortar class room situation for face to face instruction, teacher guided projects or practices. When students individualize the playlist i.e. fix or choose the schedule of rotation among the different stations and modalities i.e. face to face
instruction, group discussion, projects, online learning etc, then the Model is termed as Individual rotation

2.3.3. **Flex Model**: Institutions who are supporting a large number of non-traditional or at-risk students often choose the flex model of blended learning. With this approach, material is primarily delivered online. Although teachers are in the room to provide on-site support as needed, learning is primarily self-guided, as students independently learn and practice new concepts in a digital environment.

2.3.4. **Self-Blend Model**: The self-blend model of blended learning gives students the opportunity to take classes beyond what is already offered. While these individuals will attend a traditional classroom environment, they also opt to supplement their learning through online courses offered remotely. In order for this method of blended learning to be successful, students must be highly self-motivated. Self-blend is ideal for the student who wants to take additional Advanced Placement courses, or who has interest in a subject area that is not covered in the traditional course catalog. The model is also known as A La Carte Model.

2.3.5. **Online Driver Model**: At the opposite end of the spectrum from face-to-face driver we have online driver, which is a form of blended learning in which students work remotely and material is primarily delivered via an online platform. Although face-to-face check-ins are
optional, students can usually chat with teachers online if they have questions. The model is also known as Enriched Virtual Model. This model of blended learning is ideal for students who need more flexibility and independence in their daily schedules (Staker, H. and Michael Horn, B. 2012).

The mode of blended learning may of two types: Synchronous interaction and Asynchronous interaction. Synchronous, means ‘at the same time’, it involves interacting with a faculty member and other learners via the web in real time using technologies such as virtual classrooms and / or chat rooms. On the other hand, Asynchronous means ‘not at the same time’; it enables learners to interact with their colleagues and faculty member at their own convenience, such as interacting through email.

![Figure 2.6: Schematic diagram of blended learning approach](image)

**Figure 2.6:** Schematic diagram of blended learning approach
2.4. **Benefits of Synchronous and asynchronous learning**

When students listen to a lecture together in a classroom, they are engaged in synchronous learning mode; all students are participating in the learning process at the same time. In an online classroom environment synchronous learning activities resemblance to the traditional teaching learning situations have the following benefits;

- Students can ask questions in real-time.
- Students feel a greater sense of community and connection to their peers when they all learn together.
- Students become more engaged in their learning.
- Students feel a stronger sense of collaboration

Asynchronous communication and learning is by far the more popular learning type because many of the learning tools are free, require minimal hardware, and are used at the student’s pace (Meloni, 2010). Just as with synchronous learning, the growing increase in information communication technology and online connections has expanded the online learning opportunities available. A number of educational benefits can be observed from the use of asynchronous technologies in an online learning environment including:
Students can progress through the learning when they want, where they want, at the pace they want, in the order they want.

Students have more time to reflect on what they learned.

Shy students may feel more comfortable interacting with their professor or peers when they have time to compose thought-out emails rather than feeling pressured to speak up in a live conference.

Students can participate in the same activities regardless of time zone.

2.5. Integrated Model of Synchronous and asynchronous learning

It is clear from the research that the technologies associated with synchronous and asynchronous learning can improve the quality of student-teacher interactions, foster increased student engagement, and improve learning outcomes (Hastie, Hung, Chen, Kinsuk, 2010; Simonson et al., 2012). There are strengths and weaknesses to both designs. Some students like a synchronous online learning environment because they need face-to-face instruction. For other students, an asynchronous online learning environment provides more time to consider all sides of an issue before offering their own educated input. Both learning types have very unique benefits and limitations to online learning. In order to overcome these limitations the two learning types should be integrated (Figure 2.7) and utilized to support student needs.
within an online learning environment called blended learning (Er et al., 2009).

![Image](image.png)

**Figure 2.7:** Schematic diagram of Integrated Model of Synchronous and asynchronous learning

2.6. **Integration of technology for meaningful comprehension of Chemical Concepts:**

According to Hennessy, Ruthven and Brindley (2005), technology integration is defined as the re-shaping of teachers' educational activities in the classroom. Hew and Brush (2007) defines technology integration as teachers' use of any technology in the classroom to increase the success of the students. Learning chemistry is a complex and multifaceted cognitive activity that requires imagination—a mental effort of constructing and manipulating
symbols and models internally in order to link phenomena to abstract concepts. Many studies have made evident that integrating technology in learning through multimedia, help to conceptualize these abstract and complex concepts in chemistry as well as empower teachers’ instruction. The technology oriented multimedia based instructional environments have many features and values covering many perspectives, for instance, animation of the chemistry concepts to depict the submicroscopic nature of particles, dynamic visuals to bridge a phenomenon and the submicroscopic behavior of particles, and hypertext and visuals to relate different symbolic representations of a chemistry concept. With these characteristics and values, the instructional environment provided various opportunities for students, for example, to incorporate a substantive amount of information in multimedia that requires students to extract, analyze, manipulate, conceptualize, modify, and evaluate their internal structure of the knowledge. So, it is indicative that well-designed instruction strategies can foster students’ understanding through the use of visual displays that depict representations of chemical phenomena leading to a meaningful comprehension of chemistry (Figure 2.8). For proper integration of technology in the instructional strategies the techno pedagogical content knowledge and competency of the teacher-facilitator is very much important (Mishra and Koehler 2006).
Figure 2.8: Schematic of Transition of instructional strategies and Integration of technology for meaningful comprehension of Triplet Chemical Concepts: Macro, Sub-micro and Symbolic.

2.7. A brief journey from lecturing to pedagogy, to techno-pedagogy

At the beginning of civilization, the education was confined within a very small section of the society. In absence of any written material, priestly schools had devised a most remarkable and effective system of transferring knowledge to succeeding generations in form to hymns. Knowledge was
passed on orally from one generation to another in ancient time. And the education was restricted only to those, who possessed brilliant feats of memory and capability to keep its extreme sanctity. “Guru Shishya Parampara” is the method of teaching and learning. In the system of Gurukul the disciple was staying with the Acharya, share maximum time to get complete knowledge of the subject. In this period the Masses remained away from formal education. Even if when educational resources are available as written teaching learning materials, the teaching at the ancient universities were mostly confined to lecturing.

With the establishment of different learning theories viz. classical, behaviouristic, cognitive and constructivist learning theory, the teaching process changed abruptly from chalk and talk to activity based or teacher centered to the more learners centered. This lead to generation of different learning designs and eventually the need of development of the art-science of teaching is revealed, which refers to the new theory of pedagogy. Pedagogy includes how the teacher interacts with students and the social and intellectual environment the teacher seeks to establish (Shulman, 1987).

In the 21st century, the transition of pedagogy to techno pedagogy occurs through the rapid and innovative changes in science and technology and integrating them into classroom teaching. These changes require individuals to have digital competence or techno-pedagogical skills, the ability to use digital
technologies effectively and efficiently with the aim of developing their life skills and fostering their knowledge capacity in society (Yavuz-Konokman, Yanpar-Yelken & Sancar-Tokmak, 2013, Su, X., et al. 2017). Thus development of information technologies creates opportunities to use innovations in teaching environments (Altan & Tuzun, 2011). The integration of information and communication technologies or multimedia into education is becoming more important every day with the effect of theoretical transformations and technological developments in the teaching and learning processes (Cuhadar, Bulbul & Ilgaz, 2013, Leema, K. M., Saleem. T. M. 2017).

There are three core components to develop teacher’s techno-pedagogical competency: content, pedagogy and technology, which constitute the TPACK (technology, pedagogy and content knowledge) model (Koehler & Mishra, 2009). This TPACK model (Figure 2.9) is the extension of Shulman's pedagogical content knowledge (PCK) and adding technology to it.
Figure 2.9: The Dimensions of the Technological Pedagogical Content Knowledge Approach (Koehler & Mishra, 2009)

To integrate and synchronize all the multimedia technology based different attractive media elements in the classroom teachers need to have the knowledge of Content, Pedagogy and Technology as well as the competence i.e. the ability to apply these technologies in the proper situations according to the needs. The proper pedagogic implementation of the interactive multimedia technology based content provides interactive multisensory responses by facilitating critical and creative thinking and analyzing through challenging and thrilling experiences. The interactive nature of these technologies offers
new insight i.e. introspection into the learning procedure by facilitating independent learning to achieve high self esteem.

According to H. Connors techno-pedagogy is “Electronically mediated courses that integrate sound pedagogic principles of teaching/learning with the use of technology” (Karthigapriya, 2017). Techno-pedagogy is the art and science of incorporating technology in designing teaching learning experiences so as to improve the learning outcome. In the literature, Harris, Mishra & Koehler (2009) added technology as a modeling element to Lee Shulman’s Pedagogical Content Knowledge (PCK). Teachers, according to Shulman (1986) require mastering the interaction between pedagogy and content in order to implement strategies that help students to fully comprehend the content. The Technological Pedagogical Content Knowledge (TPACK) framework extends Shulmans’ notion (1987) of PCK by including knowledge of technology. They proposed that addressing content knowledge, pedagogical knowledge and technological knowledge concurrently provides a framework for technological integration in the curriculum. The TPACK focuses on the mutual influence of technological knowledge, pedagogical knowledge and content knowledge so as to ensure fruitful learning situation (Koehler, et al. 2004, Mishra, et al. 2006 and Koehler, et. al. 2008). But in the practical situation, for judicious implementation of the interactive multimedia based technology teachers need to acquire the ability to utilize technology i.e. competence. Thus another mutual component can be introduced into the each

1. a) Technological Knowledge (TK)
   b) Technological Knowledge & Competency (TK&C)

2. a) Content Knowledge (CK)
   b) Content Knowledge & Competency (CK&C)

3. a) Pedagogical Knowledge (PK)
   b) Pedagogical Knowledge & Competency (PK&C)

4. a) Pedagogical Content Knowledge (PCK)
   b) Pedagogical Content Knowledge & Competency (PCK&C)

5. a) Technological Content Knowledge (TCK)
   b) Technological Content Knowledge & Competency (TCK&C)

6. a) Technological Pedagogical Knowledge (TPK)
   b) Technological Pedagogical Knowledge & Competency (TPK&C)

7. a) Technological Pedagogical Content Knowledge (TPACK)
   b) Technological Pedagogical Content Knowledge & Competency (TPACK&C)

   In a contour 3D diagram (Figure 2.10), if the three primary elements viz. Technological Knowledge (TK), Content Knowledge (CK) and Pedagogical Knowledge (PK) are placed in the three Cartesian axes, then the
near faces created on the base cube can be represented as the Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK) and Technological Pedagogical Knowledge (TPK). The opposite or complementary face of Knowledge face of the base cube can be represented as the Competency of the corresponding components.

Figure 2.10: Cartesian Contour 3D diagram of TPACK&C.
2.8. Interactive Multimedia Courseware as a Techno-pedagogical Tool:

“I hear and I forget.

I see and I believe.

I do and I understand”

– Confucius.

Research has shown that people remember 20% of what they see, 40% of what they see and hear, but about 75% of what they see and hear and do simultaneously (Lindstrom, 1994). Multimedia is now permeating the educational system as a tool for effective teaching and learning as with multimedia, the communication of the information can be done in a more effective manner and it can be an effective instructional medium for delivering information. A multisensory experience can be created for the audience or learners, which, in turn, elicits positive attitudes toward the application. Multimedia has also been shown to elicit the highest rate of information retention and result in shorter learning time (Ng and Komiya, 2000).

Multimedia, defined, is the combination of various digital media types such as text, images, sound and video, into an integrated multisensory interactive application or presentation to convey a message or information to an audience. In other words, multimedia means “an individual or a small
group using a computer to interact with information that is represented in several media, by repeatedly selecting what to see and hear next” (Agnew et. al, 1996). Multimedia application design offers new insights into the learning process to represent information and knowledge in a new and innovative way (Agnew, Kellerman & Meyer, 1996). The use of computer assisted multimedia as a supplement to traditional teacher directed instruction produces positive effects. It enhances the academic performances improvements to the pre-service teachers. Computer assisted multimedia applications enhances learning rates. Student’s score on delayed tests indicate that the retention of content learned using computer assisted multimedia application is superior to retention following traditional instruction. Multimedia instructional strategy at secondary level is feasible because of its reproducibility and cost management (Kilicer, K., Bardakci, S. and Arpaci, I. 2018). A model of multimedia based teaching learning strategy has been collated in Figure 2.11.

![Figure 2.11: ‘Multimedia’ Based Teaching Learning Strategy.](image-url)
Irrespective of meaningful integration of technology in the classroom in the form of multimedia the learning will be appropriate and effective only when we follow the oldest quotation about learning by Confucius—“I hear and I forget. I see and I remember. I do I understand.” That means the learning will be effective when it occurs by doing i.e. teaching by guided activity. ‘Learning by doing’ is a useful teaching-learning technique which arises from the ‘Constructivist’ teaching-learning Philosophy and helpful for better comprehension and retention of knowledge with respect to traditional methods (Kirschner, et al. 2006; Cook, M. T. 2007; Kim, 2009).

So, if some component of activity or more precisely interactivity is incorporated into the Multimedia course material or courseware which improves learner’s activeness and motivation and this component will certainly enhance the effectiveness of the Interactive Multimedia Courseware and it will be useful for abstract comprehension.

![Relationship between Learning and Interactivity of the Courseware](image)

**Figure 2.12:** Relationship between Learning and Interactivity of the Courseware
As we know, Chemistry is always a difficult and strange subject. It is in general a tedious task to comprehend the abstract chemical concepts specifically those of organic chemistry. It is again very difficult for common merit students to grasp the symbolic dimension of the triplet model of chemical concepts viz. macro, sub-micro and symbolic (Johnstone, 1982; Gabel, 1999 and Talanquer, 2010). To understand and visualize the chemical concepts better specifically abstract symbolic part the conventional classroom interaction is not adequate (Gilbert, 2005, 2009). So, introduction and integration of technology in the classroom is a general demand in the modern technological era for proper learning outcome during the chemistry teaching (Abbitt, 2011; Chai, et.al.2011; Young, et. al. 2012; Sathiyaraj, et.al. 2013).

At the present time the Information Communication Technology (ICT) is very much improved and wide spread media component with the aid of computer based multimedia technology. Hence, compilation of computer based multimedia teaching aids is very much important in the chemistry teaching learning process for enhanced comprehension of the abstract chemical concepts. Proper compilation of technology with teaching learning process i.e. Pedagogy and Content leads to a new educational framework; (Shulman, 1987; Harris, et.al. 2009; and Koehler, et. al. 2012, 2013) Techno-Pedagogical Content Knowledge (TPACK). Thus, computer based multimedia course material and more precisely spoken courseware is a good techno-pedagogical tool. If this multimedia courseware becomes user interactive, then
it provides multisensory responses by facilitating critical, creative, analytical and innovative thinking through challenging and thrilling experiences. Again it also can reduce the learning time with reference to input variables concerned (Ng, et.al., 2000; Hofstetter, 1995). So an interactive multimedia courseware is a strong techno-pedagogical tool for constructing abstract symbolic chemical concepts like isomerism, fundamental chemical effects, reaction mechanism etc. The interactive nature of these technologies offers new insight i.e. introspection into the learning procedure by facilitating independent learning to achieve high self esteem (Neo, and Neo, 2001).

References


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Development of Interactive Multimedia Courseware in Organic Chemistry and Its Effectiveness on the Achievement of School Students

Education, Atlanta, GA. Charlottesville, VA: Association for the Advancement of Computing in Education.


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