The Role of Antecedent Knowledge and Competency of Techno-pedagogy for Judicious Implementation of Interactive Multimedia Courseware in Organic Chemistry

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Abstract - *In recent time, educational system and processes are mostly influenced by the newly developed computer based educational technologies. So, teachers need to acquire the knowledge and the techno-pedagogical competence to execute and achieve better outcomes in the teaching learning situations. Not only teachers, but students also require having minimum exposure to this computer based educational technologies. This study aimed at measuring the impact of antecedent knowledge and techno-pedagogical competence of teachers on the achievement of the learners after implementation of a complete computer based interactive multimedia courseware. For this purpose Solomon's four group research designs was adopted, where two pairs of equivalent experimental and control groups of students along with their teachers were purposively selected by matched pair sampling from two schools. During the implementation of the interactive courseware the antecedent knowledge and techno-pedagogical competence of the teachers were measured and compared. The result revealed that only knowledge is not sufficient to implement such type of technology in the classroom both knowledge and techno-pedagogical competence can be taken into consideration. Besides this, a minimum level of the antecedent knowledge and techno-pedagogical competence of teachers are also necessary for successful implementation of the Courseware. This study will be beneficial for the educational stakeholders during framing and updating the school curricula incorporating computer based educational technologies.*

Keywords: *Computer based educational technologies, Technology Mediated Classroom, Antecedent knowledge and Techno-pedagogical competency, Judicious Implementation*

INTRODUCTION

In the postmodern liberalized, globalized and digitalized age, the paradigm shift in the teaching learning process is inevitable to meet the digital challenge leading to the implementation of computer based technology inside the teaching-learning processes of the educational system. So it is needed to introduce the multimedia based Information Communication Technology (ICT) into the today's classroom. It facilitates effective teaching-learning process by enhancing connectivity, innovative sharing of knowledge and reducing socio-economic, cultural and geo-graphical barriers. Mere introduction of technology is not sufficient for improvement of teaching learning process; rather integration of the technology into the classroom is important [1-5]. For this purpose digital competence i.e. ability to use digital technology effectively and efficiently is the foremost requirement to run the system smoothly [6]. So, teachers need to be fluent in the usage of educational technology with the latest tools to understand, develop and author the complex web of relationships among users, technologies, practices, and tools. Teachers must understand their role in technologically-oriented classrooms [7, 8].

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 Connors [9] techno-pedagogy is "Electronically mediated courses that integrate sound pedagogic principles of teaching/learning with the use of technology". 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 et. al. [10] added technology as a modeling element to Lee Shulman's Pedagogical Content Knowledge (PCK). Teachers, according to Shulman [11, 12] 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 of PCK by including knowledge of technology. They proposed that addressing content knowledge, pedagogical knowledge and technological knowledge concurrently provides a frame work 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 [13-16]. 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 of seven basic components of TPACK framework [17-19].

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 1), 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.

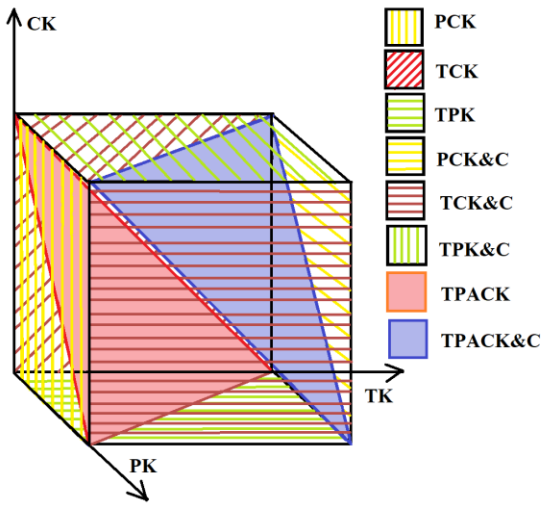

Figure 1: Cartesian Contour 3D diagram of TPACK&C

From the above literature review it is clear that knowledge and competency of techno-pedagogy is important for integrating the computer based technology inside the classroom but no mention of how much and the threshold value or level of it for successful integration and implementation of the technology. In this study the antecedent knowledge and competency of techno-pedagogy of the teachers and students were measured during the implementation of computer based interactive multimedia courseware and evaluated how the antecedent knowledge and competency of techno-pedagogy of the teachers and students influenced the achievement of students.

METHODOLOGY

A mixed-method research, particularly convergent parallel design was followed in this study, where the researchers simultaneously collected both quantitative and qualitative data, merged the data, and use the results to understand the research problem. In this study an evaluative experimental teaching learning process was carried out, to find out how the antecedent knowledge and competency of techno-pedagogy in the teachers and students influence the performance of students after implementation of the self-developed interactive multimedia courseware in organic chemistry [20] among the students of class XI of two reputed schools at the Burdwan Town, West Bengal, India.

The antecedent knowledge and competency of techno-pedagogy of teachers and students were assessed using a questionnaire during the implementation of the self-developed interactive multimedia courseware in organic chemistry. For this purpose Solomon's Four Group Research Design [21] was adopted, where the two pairs of equivalent groups were structured by matched pair sampling namely i) Experimental Group and ii) Control Group. For this purpose, students were selected from two comparable schools with respect to their results in the Board examination for each pair of groups.

2 Groups ×

Experimental Group (E)	**0**	X_1	T_2
Control Group (C)	**0**	X_2	T_2

Students of each and every group were taught organic chemistry by traditional chalk and talk method. Then the students of the experimental groups were allowed to play with the interactive multimedia courseware under the supervision of their teachers and consulted with them. Finally an achievement test was administered on both pair of groups separately and the data was collected and compared (Figure 2).

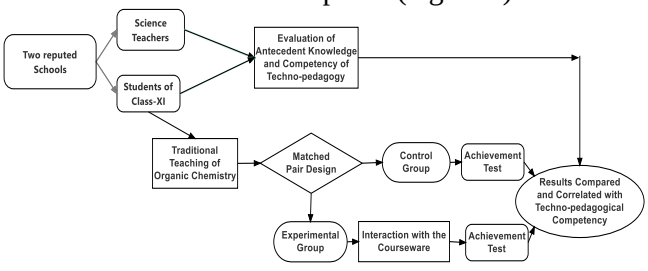

Figure 2: Flow Chart of the Experimental Design

RESULTS AND DISCUSSION

From the Comparative graph of percentage (%) of Correct Responses by the students on the achievement test in Organic Chemistry of the two pairs of group clearly indicate that the performance of the students of Group-1 was higher than Group-2 as well as their progress in the performance after interacting with the interactive multimedia based courseware i.e. experimental group is also better than their counter part i.e. control group (Table 1 & Figure 3). This result undoubtedly points to the presence of some intervening variables and which is discussed and interpreted from the result in the fore going part of the article.

Table 1: The percentage (%) of correct responses by the students on the test of Organic Chemistry

School	Experimental Group	Control Group	Difference
Group-1	68.16	41.5	26.66
Group-2	57	37.83	19.17

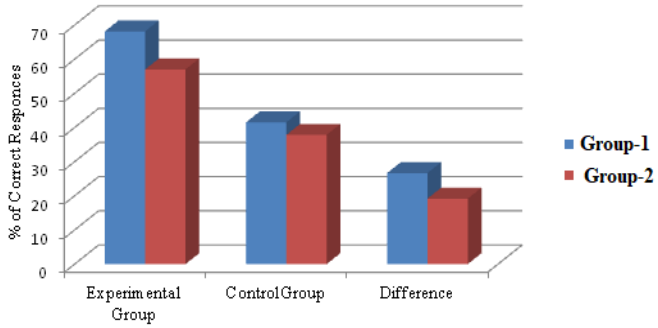

Figure 3. The percentage (%) of correct responses by the students on the test of Organic Chemistry

The knowledge and competency of Techno-pedagogy of the individual can be evaluated by their accessibility towards the different multimedia based equipment like Tablet, I-pod, Laptop, Desktop, Printer, Photocopier, Scanner, Internet, Projector, Interactive White Board, Camcorder, Virtual Classroom etc. and how they are familiar to different Software like MS-Word, MS-Excel, MS-Power Point, Windows Movie Maker, Photoshop, Chem-draw, Flash, Autodesk Maya etc. as well as how far they utilize them. In spite of the above the knowledge and competency of Techno-pedagogy is also related to the rate and how long they use different social networks like SMS, Email, Chat, Group, Blog, Facebook, Whatsapp, Instagram, twitter etc.

Table 2. Different Multimedia based equipment used by Teachers (%) in the Institution, Community or personally related to the two Groups

	Group-1			Group-2		
EQUIPMENT	Community	Personal	Institution	Community	Personal	Institution
1. Tablet, I-pod	0	40	0	0	62	0
2. Laptop	10	90	0	0	62	0
3. Desktop	40	40	100	12	37	50
4. Printer	40	10	90	12	25	62
5. Photocopier	40	10	70	25	0	25
6. Scanner	40	0	60	12	25	25
7. Internet	40	90	90	12	50	50
8. Projector	10	0	60	0	0	62
9. Interactive White Board	10	10	70	0	0	0
10. Camcorder	0	10	20	0	0	12
11. Virtual Classroom	0	0	40	0	0	0

The results of the questionnaire for evaluating the knowledge and competency of Techno-pedagogy of the science teachers related to the two Groups reveal that all the teachers related to the Group -1used Desktop in their institution whereas 50% of teachers related to group-2 used Desktop in their institution. Similarly, 90% of the teachers related to the Group -1 used Printer in their institution where as only 62% of teachers related to group-2 used Printer in their institution and so on. Although a higher percentage of the teachers related to group-2 used Tablet, I-pod compared to the teachers related to the Group -1, but it was personal usage for recreation. Thus it is clear that the teachers related to the Group -1 have more accessibility towards the Multimedia based equipment than Group-2 (Table-2) which provide opportunity to the science teachers related to the Group-1 to utilize the Multimedia based equipment frequently.

Table 3: Different Utility Software familiar and utilized by Teachers (%) related to the two Groups

	Group-1			Group-2		
Software	R	O	F	R	O	F
1. MS-Word	0	20	70	0	37	25
2. MS-Excel	0	50	30	0	25	37
3. MS-Power Point	10	0	50	25	37	0
4. Windows Movie Maker	20	0	10	12	0	0
5. Photoshop	10	10	30	12	12	0
6. Chem-draw	0	30	0	0	0	0
7. Flash	0	10	10	0	0	0
8. Autodesk Maya	0	10	0	0	0	0

R – Rarely; O – Occasionally; F - Frequency

If the results of the comparative Table of Different Software used by the teachers related to the two Groups are minutely observed, the difference in the familiarity and utilization of different utility software by the science teachers related to the two Groups can easily be distinguished. The science teachers related to the Group-1 are more familiar to the different utility software than the science teachers related to the Group-2 as well as they utilize this software more frequently (Table-3).

In this self-evaluative survey another aspect was also rendered that the use of social networks by the science teachers related to the two Groups are comparable but still it is higher among the teachers related to the Group-1 (Table-4). From this comparative discussion it is clear that the knowledge and competency of Techno-pedagogy of the science teachers related to the Group-1 is higher than the Group -2.

Table 4: Different Social Networks used by Teachers (%) related to the two Groups

	Group-1			Group-2		
Social Networks	R	O	F	R	O	F
1. SMS	0	10	90	12	25	75
2. Email	0	30	70	0	25	62
3. Chat	0	20	70	12	25	62
4. Group	20	10	20	0	0	50
5. Blog	10	10	30	12	0	0
6. Facebook	20	20	60	37	25	25
7. Whatsapp	0	10	90	25	0	75
8. Instagram	10	0	10	0	0	37
9. Twitter	10	20	0	12	0	0

R – Rarely; O – Occasionally; F - Frequency

In this study, the result of the questionnaire for evaluating the knowledge and competency of Techno-

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pedagogy of students was so inconsistence that it is inconclusive.

From the discussion so far it is clear that the intervening variable which mentioned earlier is the Antecedent Knowledge and Competency of techno-pedagogy of teachers. So, the performance of the students of Group -1 was better compared to Group -2 as it was observed that the Antecedent Knowledge and Competency of techno-pedagogy of teachers related to Group -1 was superior than that of Group -2. This study indicated that teachers should have a particular level of antecedent Knowledge and Competency of techno-pedagogy for appropriate integration and judicious implementation of computer based technology inside the classroom to enhance the performance of school students.

CONCLUSION AND RECOMMENDATION

The computer based technological boom in the all sphere of the society also influence the educational technology which leads to change in the adopted teaching process by the teachers as well as the learning process of the student. The above experimental study undoubtedly established the influence of the antecedent knowledge and competency of Techno-pedagogy on the implementation of the interactive multimedia courseware in Organic Chemistry. Beside still the importance of face to face interaction of student and teacher cannot be ignored but their mode of interaction may be changed to the different social networking as it offers a popular technological direct interaction among the users.

Thus, during framing and updating the school curricula incorporating computer based educational technologies, educational stakeholders should remember - for getting maximum effect of any multimedia based course design to enhance the performance of the students there should be a judicious implementation of the interactive multimedia courseware mixing with the face to face interaction or popular technological direct interaction between student and teacher as well as it should clarify and make provision to orient the teachers for attaining the threshold level of knowledge and competency of techno-pedagogy. Apart from that, those curricula have to be designed in such a way so that knowledge and competency of Techno-pedagogy of the teachers and students can be uplifted during the implementation of the programme.

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NOTES

The authors declare no competing financial interest.

REFERENCES

[1] Abbitt, J. T. (2011**)** Measuring technological pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *J. of Research on Technology in Educ.* 43(4), 281-300.https://doi.org/10.1080/15391523.2011.10782573.

[2] Abitt, J. T. (2011) An Investigation of the Relationship between Self-Efficacy Beliefs about Technology Integration and Technological Pedagogical Content Knowledge (TPACK) among Pre-service Teachers. *J. of Digital Learning in Teacher Educ.* 27(4), 134-143.

[3] Chai, C. S.; Ling Koh, J. H.; Tsai, C.; Wee Tan, L. L. (2011) Modeling primary school pre-service teachers' technological pedagogical content knowledge (TPACK) for meaningful learning with information and communication technology (ICT), *Computers & Educ.* 57, 1184-1193. https://doi.org/10.1016/j.compedu.2011.01.007.

[4] Young J. R.; Young J. L.; Shaker Z. (2012) Describing the Pre-service Teacher Technological Pedagogical Content Knowledge (TPACK) Literature Using Confidence Intervals, *Tech-Trends.* 56 (5), 25-33. DOI: 10.1007/s11528-012-0600-6.

[5] Sathiyaraj, K.; Rajasekar, S. (2013) The Relationship between the Techno-Pedagogical Competency of Higher Secondary School Teachers and their Anxiety towards the Use of Instructional Aids in Teaching. *Int. J. of Teacher Educ. Research.* 2(12), 7-14.

[6] Monsivais, M. I.; McAnally, L.; Lavigne, G. (2014) Application and validation of a techno-pedagogical lecturer training model using a virtual learning environment. *Revistade Universidady Sociedaddel Conocimiento*, 11(1), 91-107. http://doi.dx.org/10.7238/rusc.v11i1.1743.

[7] Thakur, N. (2015) A Study on Awareness of Trained Teachers in relation to Information and Communication Technology. *J. of Res. & Method in Educ.* 4(1), 06-11.

[8] Leema, K. M.; Saleem, T. M. (2017) Infusion of Techno Pedagogy in Elementary Teacher Education Curriculum: Perspectives and Challenges. *Journal of*

Humanities and Social Science. 22 (1), 06-10. DOI: 10.9790/0837-2201010610.

[9] Karthigapriya, M.D. (2017) Techno-pedagogy in teaching and learning, *Shanlax Int. J. of Educ. 5* (1), 8-11.

[10] Harris, J.; Mishra, P.; Koehler, M. (2009) Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration refrained. *J. of Research on Technology in Educ. 41*(4), 393-416. http://dx.doi.org/10.1080/15391523.2009.10782536.

[11] Shulman, L. S. (1986) Those who understand: Knowledge growth in teaching. *Educational Researcher*. 15(2), 4–14.

[12] Shulman, L. S. (1987) Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*. 57(1), 1–22.

[13] Koehler, M. J.; Mishra, P.; Yahya, K. (2004) Content, pedagogy, and technology: Testing a model of technology integration. Paper presented at the annual meeting of the American Educational Research Association, April 2004, San Diego, CA.

[14] Koehler, M. J.; Mishra, P.; Yahya, K.; Yadav, A. (2004) Successful teaching with technology: The complex interplay of content, pedagogy, and technology. Proceedings from the Annual Meeting of the Society for Information Technology & Teacher Education, 2004**,** Atlanta, GA. Charlottesville, VA: Association for the Advancement of Computing in Education.

[15] Mishra, P.; Koehler, M. J. (2006) Technological Pedagogical Content Knowledge: A new framework for teacher knowledge. *Teachers College Record*. 108(6), 1017-1054. http://dx.doi.org/10.1111/j.1467-9620.2006.00684.x.

[16] Koehler, M.J.; Mishra, P. (2008**)** Introducing TPCK. AACTE Committee on Innovation and Technology (Ed.), The handbook of technological pedagogical content knowledge (TPCK) for educators (pp. 3-29). 2008, Mahwah, NJ: Lawrence Erlbaum Associates.

[17] Schmidt, D. A.; Baran, E.; Thompson A. D.; Koehler, M.J.; Mishra, P.; Shin, T. (2009) Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for pre-service teachers. *J. of Research on Technology in Educ*. 42(2), 123–149.

[18] Koehler, M. J.; Shin, T.S.; Mishra P. (2012) How Do We Measure TPACK? Let Me Count the Ways. In Ronau, R. N., Rakes, C. R. & Niess, M. L. (Eds.) *Educational Technology, Teacher Knowledge, and Classroom Impact: A Research Handbook on Frameworks and Approaches*, (an imprint of IGI Global, Chap.2 pp16-31). 2012, *USA*: Information Science Reference.

[19] Koehler, M.; Mishra, P.; Cain, W. (2013) What is technological pedagogical content (TPACK)? *J. of Educ*. 193(3), 13-19.

[20] Sana, S., Adhikary, C., & Chattopadhyay, K. N. (2018). Interactive Multimedia Courseware: An Effective Techno-pedagogical Tool for Developing Basic Concepts of Organic Chemistry. *Review of Research J.* 8(1), 35-42.

[21] Mario, A. N., & Jason, T. S. (2018). Solomon Four-Group Design. In Bruce B. Frey (Eds.) *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation* (1st ed., pp 1553-1554). Thousand Oaks, US: SAGE Publications, Inc. DOI: http://dx.doi.org/10.4135/9781506326139.n645.