Research Article

Study of the Significance of Integrating Technology for Inquiry (NTeQ) Model in Undergraduate Teacher Education Programme

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Abstract

Technology infusion in formal classroom teaching-learning supports the students in conceptual learning, retention and enrichment. Integrating Technology for Inquiry (NTeQ) model is a computer-based sequential learning innovation that integrates technology to promote inquiry-oriented, problem-solving or project-based learning. Present descriptive survey research was conducted to gauge the curricular implications of the NTeQ model and explore the attitude and learning experience of prospective teachers of undergraduate teacher education programs of teacher education institutions of GGSIP University, Delhi. Data analysis showed that in institutions, mere theoretical discussion on the NTeQ model and lack of interactive sessions in computer laboratories restricted the prospective teachers from retrieving the conceptual framework of the NTeQ model in the examination. This also led prospective teachers to develop a neutral attitude towards the NTeQ model as a learning tool. The teacher educators expressed the dire need for professional development programmes for themselves to explore the NTeQ model as a learning tool in formal classroom teaching-learning scenarios. The adequate technical infrastructure of teacher education institutions, simulation-based teaching practice through the NTeQ approach and incorporation of practical activities on the NTeQ model in the curriculum may promote the learning implications of the NTeQ model in classrooms. The study had educational implications for concerned stakeholders.

Keywords: NTeQ model, Computer literacy, Learning implications, Pedagogical tool

Introduction

The exponential advancements in the use of the internet and technology in formal education have led to the emergence of Integrating Technology for Inquiry (NTeQ) model lesson design as an innovative pedagogical tool for academic instruction in classrooms (Morrison & Lowther, 2003). The NTeQ model is an infusion of higher-order thinking in technology (Flake, 2017). Higher-order thinking is referred to as any activity that requires the students to process information in some meaningful ways (Morrison & Lowther, 2005) and includes critical thinking, problem-solving, creative thinking, Bloom's taxonomy and metacognition. The NTeQ model is goal-oriented, interactive and student-centred; it focuses on the meaningful performance of the students and reliable and valid measurement of outcomes through the self-correcting team efforts of the students (Branch & Merrill, 2012). NTeQ model is an inquiry-based ten-step lesson design process for integrating technology into the curriculum to promote problem-solving among the students, hence leading to project-based learning (Lowther & Morrison, 2003).

As an instructional design, the NTeQ model is constructivist in origin as the student is empowered to explore like a researcher, whereas the teacher acts as a facilitator, designer and organiser of learning activities (Morrison et al., 1999). After learning through NTeQ model-based instructions, a student's competence to act and respond to queries, problem-solving, and discuss ideas and outcomes are enhanced (Lowther & Morrison, 1998). The NTeQ model promotes collaborative help learning among students (Ikepeze, 2006). It has been observed that the NTeQ model could not be so popularised among educators. The plausible reason for the unfamiliarity of the NTeQ model for educators may be this role reversal between student and teacher that appears somewhat non-conventional (Flake, 2016).

Operationally, the NTeQ model works in the following ten phases (Lowther & Morrison, 1998):

i. Specify Objectives: The first concern for the teacher using the NTeQ model is to explore what learning objectives will the students achieve after completing the given lesson? This phase focuses on developing specific learning objective(s) for the content.

ii. Computer Functions: In this phase, the teacher matches the developed specific learning objectives to computer functions and activities.

iii. Specifying a Problem: This phase involves the specification of the problem by the teacher.

iv. Data Manipulation: The teacher briefly describes each manipulation activity to explain how to use data. In this phase, there is a focus on research and analysis that involve planning for data collection.

v. Results Presentation: This phase concerns the presentation of results by the students.

vi. Activities During Computer Use: What will the students do while using the computer? This is answered by this phase, where a listing of the activities planned for working while working on the computer is done. The concern of paramount importance is that there must be a correlation between these activities and the specified learning objectives.

vii. Activities Before Computer Use: In this phase, the activities are planned before using the computer. It lists the activities which the students will perform while working on the computers.

viii. Activities After the Computer Use: This phase is a reflection on learning. There is a planning of activities to record, analyse and interpret the information generated by using the computer.

ix. Supporting Activities: This phase is the planning of supporting activities that enable the students to achieve the specified learning objectives. The supporting activities may be reading, reviewing, and associated enrichment activities.

x. Assessment: This phase is the development of assessment strategies.

The computer-based activities are the core activities of the NTeQ model (Williams & Anekwe, 2017), where the computer serves as a learning device. The NTeQ model, as a pedagogical tool, requires a certain degree of technological competence on the part of students (Mishra & Koehler, 2006). The student-centeredness in learning through computers in the NTeQ model develops a spirit of ownership among the students to use technology with zeal and enthusiasm, and thus, it leads to a higher level of inquiry on their part (Morrison & Lowther, 2010). There are a

few assumptions while using the NTeQ model in the classroom (Van Eck, 2009), which can be summarized in table 1:

Table-1: NTeQ model and its assumptions

S.N.	Aspect	Assumption
1.	Teacher	(i) Teacher has functional computer literacy. (ii) Teacher is proficient enough in integrating the technology into the curriculum; (iii) Teacher can motivate the students to use technology in effective ways.
2.	Student	(i) Student can use the technology; (ii) Through exploration, the student may gain competence in using the technology.
3.	Technology	(i) Technology supports problem-solving.
4.	Lesson	(i) Lesson is student-centred; (ii) Lesson offers authentic problem-solving; (iii) Lesson can integrate technology with itself.
5.	Learning environment	(i) Learning environment focuses on activities.

Review of Related Literature

Technology integration with school teaching supports the teachers in attaining learning outcomes (Clark, 1998). The attitude of pre-service and in-service school teachers has an influence on technology integration in their teaching (Fu, 2013). Lack of administrative and financial support at institutional levels restricts teachers from using technology in classrooms (Suleman et al., 2011). The NTeQ model supports the teachers in developing extended problem-solving skills among the students and project-based learning using real-world resources, through student collaboration, that support in arriving at solutions or creating final products (Penuel, 2006). In the NTeQ model, the computer, as a learning tool, can be employed to motivate students' critical thinking in exploring the academic content (Lucey & Grant, 2010). The NTeQ model offers teachers a learning approach to integrate easily adaptable technology in the instructions (Lucey & Shifflet, 2013). Teachers using inquiry-based pedagogical approaches had a preferential tendency to use technology in classroom teaching-learning as compared to the teachers adhering to conventional lecture methods (Mayor, 2014). To explore the gains of the NTeQ model, the student has to be tech-savvy as well as a netizen, and on the other hand, the teacher has to be a digital native (Williams & Anekwe, 2017). As an instructional tool, the NTeQ model is empirically supported with respect to efficacy, heuristics and templates for its implementation in classrooms (Van Eck, 2009). The review of related literature shows that most of the studies pertaining to the NTeQ model have been conducted at higher education level, and it is an under-researched knowledge domain in school education. The NTeQ model and its educational implications in Indian school classrooms are yet to be explored.

Research Questions

The review of related literature supported the investigator to frame the following research questions for this study:

i. How does the NTeQ model, as a learning tool, facilitate prospective teachers in acquiring knowledge?

ii. How does the NTeQ model support teacher educators in inculcating pedagogical skills among prospective teachers?

Research Objectives

To explore the research questions framed for this study, the following research objectives were developed by the investigator:

i. To study the curricular implications of the NTeQ model in the undergraduate teacher education program of GGSIP University, Delhi.

ii. To study the attitude of prospective teachers of the undergraduate teacher education programs of GGSIP University, Delhi, towards the NTeQ model as a learning tool.

iii. To gauge the learning experience of prospective teachers of the undergraduate teacher education program of GGSIP University, Delhi, pertaining to the NTeQ model.

iv. To explore the perception of teacher educators of the undergraduate teacher education program of GGSIP University, Delhi, for the learning implications of the NTeQ model.

Delimitation of the Study

In Delhi, its five universities that offer undergraduate teacher education programs are Guru Gobind Singh Indraprastha (GGSIP) University, Delhi; University of Delhi, Delhi; Indira Gandhi National Open University, New Delhi; Jamia Millia Islamia, New Delhi and Lal Bahadur Shastri Vidyapeeth, New Delhi. Only the undergraduate teacher education program curriculum of GGSIP University offers the course content for the NTeQ model. So, as a delimitation of this study, data was collected from GGSIP University, Delhi only.

Research Design

To explore the research objectives framed for this study, it was essential to gauge the present status of teaching-learning pertaining to the NTeQ model being practised in undergraduate teacher education programs so the descriptive survey research design was used for data collection.

Sample

The undergraduate teacher education programme is offered by 24 teacher education institutions affiliated with GGSIP University, Delhi. Out of these, six (6) institutions were randomly selected for data collection. 440 prospective teachers (B.Ed. students) and 42 teacher educators from these six institutions were randomly selected as the final sample of the study.

Tools

i. To explore the curricular implications of the NTeQ model in the undergraduate teacher education program of GGSIP University, Delhi, content analysis was employed as a research tool.

ii. A 5-point Likert Scale was developed by the investigator to study the attitude of prospective teachers of the undergraduate teacher education program of GGSIP University, Delhi, towards the NTeQ model as a learning tool. The content validity of the attitudinal scale was established after discussion with

subject and research experts. The reliability of the attitudinal scale was established through the Cron-Batch Alpha test, and it was found to be 0.80. The initial draft of this tool had 23 Likert items, and the final draft of the same had 20 Likert items.

iii. Focussed Group Discussion (FGD) was conducted to explore the learning experience of prospective teachers of the undergraduate teacher education program of GGSIP University, Delhi, pertaining to the NTeQ model.

iv. A Structured interview was conducted to gauge the perception of teacher educators of the undergraduate teacher education program of GGSIP University Delhi for the learning implications of the NTeQ model. The initial draft of the interview schedule had nine items, but after discussion with subject and research experts its content validity was established and two items were discarded. So, the final draft of the interview schedule had 7 items.

Procedure

The 5-point Likert Scale was administered to 440 prospective teachers, and focus group discussion was held with 71 prospective teachers of 6 teacher education institutions. The interview was conducted to collect data from 42 teacher educators, teaching core theory course (critical understanding of ICT = 1 teacher educator) and pedagogy courses (mathematics, integrated science, physics, chemistry, biology, business studies, and social science = 6 teacher educators, integrated science was being taught by any one of the teacher educators of physics, chemistry or biology).

Results & Discussion

i. To explore the curricular implications of the NTeQ model in the undergraduate teacher education program of GGSIP University, Delhi the content analysis was employed as a research tool. The concept of the NTeQ model is offered in one core course (critical understanding of ICT) in the first semester and seven pedagogy courses (mathematics, integrated science, physics, chemistry, biology, business studies, and social science) in the second semester. There are 18 pedagogy papers out of which seven pedagogy papers have the NTeQ model as course content. Table 2 shows those core and pedagogy papers and the concerned course content with respect to the NTeQ model.

Table-2: NTeQ model-based course content of undergraduate teacher education programme

S.N.	Course	Course content of NTeQ model
1.	Critical Understanding of ICT	Unit: ICT for Teaching-Learning: Possibilities and Concerns *NTeQ Model
2.	Pedagogy of Mathematics	Unit: Professional Development of Mathematics Teachers *Technology Integration: Planning with the integrating Technology for inquiry (NTeQ) model for Mathematics at secondary school level

3.	Pedagogy of Social Science	Unit: Professional Development a Social Science Teacher *Preparing the Teacher for Technology Integration: Planning with integrating Technology for inquiry (NTeQ) in Social Science at secondary school level
4.	Pedagogy of Business Study	Unit: Professional Development of a Business Studies Teacher *Technology Integration: Planning with the integrating Technology for inquiry (NTeQ) model for Business Studies at secondary school level
5.	Pedagogy of Integrated Science	Unit: Professional Development of an Integrated Science Teacher *Preparing the Teacher for Technology Integration: Planning with integrating Technology for inquiry (NTeQ) in Science at secondary school level.
6.	Pedagogy of Physics	Unit: Professional Development of a Physics Teacher *Preparing the Physics Teacher for Technology Integration: Planning with integrating Technology for inquiry (NTeQ) in science at secondary school level
7.	Pedagogy of Chemistry	Unit: Professional Development of a Chemistry Teacher *Preparing the Teacher for Technology Integration: Planning with integrating Technology for inquiry (NTeQ) in Science at secondary school level.
8.	Pedagogy of Biology	Unit: Professional Development of a Biology Teacher Preparing the Biology Teachers for Technology Integration: Planning with integrating Technology for inquiry (NTeQ) in science at secondary school level

The course content for the NTeQ model is just introductory and theoretical in nature with the no practical implications for prospective teachers. The courses are restricted to only the planning aspect of the NTeQ model. The course content could be strengthened through practising NTeQ model-based lesson plans in the internship programme.

ii. Table 3 shows the attitude of prospective teachers of the undergraduate teacher education program of GGSIP University, Delhi, towards the NTeQ model.

Table-3: Attitude of prospective teachers of the undergraduate teacher education program of GGSIP University, Delhi towards NTeQ model as a learning tool

	Attitude			
	Positive	**Neutral**	**Negative**	**Total**
No. of prospective teachers	44 (10%)	339 (77.04%)	57 (12.96%)	440

It can be observed from table 3 that one-tenth (10 per cent) of the total sample of prospective teachers had a positive attitude; more than one-tenth (12.96 per cent) of the total sample of prospective teachers had negative attitude while more than three fourth (77.04 per cent) of the total sample of prospective teachers had neutral attitude.

To confirm the data shown in table 3 that whether this attitudinal tendency of the majority of prospective teachers for the NTeQ model was a chance factor, the chi-square test was employed by the investigator. Table 4 shows the chi-square test for the attitude of prospective teachers of the undergraduate teacher education program of GGSIP University, Delhi, towards the NTeQ model.

Table-4: Chi-square test for the attitudinal scores attitude of prospective teachers of undergraduate teacher education program of GGSIP University, Delhi towards NTeQ model

	Positive Attitude	Neutral Attitude	Negative Attitude
f_o	44	339	57
f_e	146.6	146.6	146.6
$(f_o - f_e)$	-102.6	192.4	-89.6
$(f_o - f_e)^2$	10,526.76	37017.76	8028.16
$\frac{(f_o - f_e)^2}{f_e}$	71.81	252.51	54.77

Total chi-squares (χ^2) value = 71.81 + 252.51 + 54.77 = 379.09

Degree of freedom (f) = 3 -1 =2

The obtained chi-square (χ^2) value 379.09 for 2 degrees of freedom is significant at 0.01 level of significance so, it can be concluded that the neutral attitude of the majority of prospective teachers for NTeQ model was a not a chance factor. The plausible reason for the majority of the total sample of prospective teachers having a neutral attitude towards the NTeQ model as a learning tool, might be just theoretical deliberation in the classroom. As teaching the NTeQ model, besides focus on theory component, requires rigorous exposure to the activity phase also and if the latter is not practiced then the prospective teachers might not develop a liking for this innovative approach that is the NTeQ model.

iii. To explore the learning experience of prospective teachers pertaining to the NTeQ model, the Focussed Group Discussion (FGD) was centred on the teaching methodology adopted by teacher educators, interactive sessions in the computer laboratory and assignments/project work. The prospective teachers unanimously responded that all pedagogy teacher educators were focussing on the mere theoretical discussion on the NTeQ model to complete the syllabus. For the end-semester examination, prospective teachers prepare themselves to answer questions through online literature, as in the library, the available textbooks are heavily loaded with technical terms and definitions. In the computer laboratory, the latest and upgraded software are needed to practice the NTeQ model as a learning

tool. Completing assignments or project work on the NTeQ model in a computer laboratory is time-consuming. Teachers' competence in using computers for the NTeQ model needs more professional input. The probable reasons for this finding may be that the curriculum emphasises on mere teaching and discussion of NTeQ model.

iv. To gauge the perception of teacher educators of undergraduate teacher education program for the learning implications of NTeQ model, the structured interview was conducted. Out of 42 teacher educators of 6 institutions, more than three-fourth (76.2 per cent) teacher educators agreed that in the classroom, their teaching is confined up to theoretical discussion about NTeQ model. In integrated science, physics, chemistry or biology, the curriculum is spiral in nature and the prospective teachers may work with NTeQ model with increased degree of complexities of the content. Similarly, the concentric nature of social science curriculum may also facilitate the prospective teachers to learn, enrich and retain the concepts through NTeQ approach. All of the teacher educators expressed that they need to attend professional development programmes like workshops where they may themselves practice NTeQ model as learning and instructional tools. They also opined that in school internship programme, practice- teaching through NTeQ model-based lesson plans is difficult as it requires an updated computer laboratory with sufficient computer machines and uninterrupted internet in schools. Moreover, the course content of school subjects is not so much flexible to allow students to contribute through the NTeQ model and hence restricts its learning implications. The plausible reason for this finding might be the lack of technical infrastructure in schools and higher education systems. The professional development programmes of teacher educators need to be interactive and activity-based rather than mere information and discussion-oriented.

Educational Implications for Stake-holders

1. **Curriculum planners:** The undergraduate teacher education curriculum needs to be upgraded by incorporating of practical activities on the NTeQ model for end-semester examination. The practical activities must specify the learning outcomes of associated computer laboratory work for the NTeQ model.
2. **Teacher educators:** Through simulation, the teacher educators may facilitate the prospective teachers to practice the NTeQ approach and present at least two to three lesson plans in the allotted two pedagogic subjects. The teacher educators need to attend workshops on learning innovative technology tools like the NTeQ model with a professional commitment to practice with the students in a computer laboratory. They may themselves research the NTeQ model and its applications in classrooms as it may better acquaint them with its conceptual framework.
3. **Prospective teachers:** The prospective teachers should not cram the conceptual framework of the NTeQ model only for examination purposes, but they should practice the NTeQ model as a learning tool in the computer laboratory. Peer tutoring may support prospective

teachers in exploring the NTeQ model as a pedagogical approach in classrooms.

Conclusion

The NTeQ model effectively brings in cohesion to the concerned elements of instruction, namely the learners, teachers, technology, content and learning environment. Theoretical discussion on the NTeQ model in classrooms, lack of technical infrastructure in teacher education institutions and average computer competence of teacher educators do not motivate the prospective teachers to practice the NTeQ model as a learning tool. Insufficient computers and slow speed internet obstruct the usage of the NTeQ model in classroom teaching-learning. The prospective teachers should use the NTeQ model with respect to some technologically viable content, at least as assignment work, in their pedagogy subjects. Besides stressing the theoretical understandings pertaining to the NTeQ model, the curriculum planners need to focus on emphasizing its uses and practice in bachelor-level teacher education internship programmes.

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