The Grounding of a Discipline: Cognition and Instruction in Technology Education

Priya Raman, Assistant Professor

Department of Commerce & Management, Arka Jain University, Jamshedpur, Jharkhand, India

Email Id- priya.raman@arkajainuniversity.ac.in

ABSTRACT: Technology education has long tried to establish itself as an equal partner in general education and has failed to obtain recognized for the value of its teaching. Frequently technology educators claim the success of their programs based on anecdotal data collected from their classroom experiences on how their teaching techniques empower kids to learn. Although technology education began without any significant input from cognitive science research, it seems that technology education teaching techniques are strikingly consistent with discoveries from cognitive science that characterize effective training. Specifically, there is significant concordance between how teaching in technology education and cognitively based instructional paradigms such as collaborative learning, socially dispersed knowledge, design/engineering, and project-based instruction may be linked. The importance of the cognitive research results on teaching may influence a long over-due theoretical foundation of instruction in technology education. The paucity of research on learning and teaching in technology education may be ascribed to a lack of theoretical foundation in this relatively young area. This article analyzes four cognitively based models of teaching and discusses the connections between research in the cognitive sciences on learning and instruction in technology education. The consonance between the research suggestions from the cognitive sciences and practice in technology education teaching may help to generate discussion on the theoretical underpinning of a new area of study.

KEYWORDS: Cognitive Science, Instructional Theory, Technology Education.

1. INTRODUCTION

The United States and indeed the global community are undergoing an unparalleled era of technological transformation. Technology has grown so user friendly that most people of technologically enabled cultures use technology with little comprehension of how it works, the consequences of its usage, or awareness of where the technology originates from. This situation gives rise to a crucial discussion of who or where the charge will rest to allow people to identify technical implications, contemplate technology's difficulties, evaluate its effects, and make educated choices about its use or non-use. The latter decades of the 20th century saw a torrent of national and international studies bemoaning the difficulties facing science and technology ideas in the United States and 25 participant nations[1].

Most studies indicated that a majority of pupils were losing interest in science and technology and falling behind their global counterparts in performance in these educational areas. For advice on the scientific and technological issues that frequently pervade policy decisions, the leaders of the United States of America often turn to the institutions that were specially created for the purpose of informing a nation on issues of critical need: The National Academy of Sciences and its sister organizations – the National Academy of Engineering, the Institute of Medicine, and the National Research Council[2]. Recent suggestions from the National Academy, and National Science Foundation sponsored Standards for Technological Literacy: Content for the study of technology supports the introduction of the study of technology for all pupils. In addition, these efforts have acted as a catalyst to revitalize the discourse and discussion as to the role and interplay between technology with the study of other disciplines such as mathematics, the social sciences, and in particular science.

In addition, the United Nation's Educational, Scientific and Cultural Organization (UNESCO) have weighed in on this debate via their Innovations in Science and Technology Education series of publications from 1984. While each of the publications and related organizations make distinct assumptions about technology and technology education, there is some agreement on what students should know and be able to accomplish as a consequence of studying technology[3]. The fundamental underpinnings of the reform movements call for understanding concepts and principles of technology such as design, control, and systems, and also key ideas about technology in specific areas such as construction, energy and power, manufacturing, and information/communication technology. One significant and relatively new concept is that of scientific literacy, which inevitably involves comprehending technology[4].

The American Association for the Advancement of Science has suggested that science literacy should include being familiar with the natural world and respecting its unity; being aware of some of the important ways in which mathematics, technology, and the sciences depend upon one another; understanding some of the concepts and principles of science; having a capacity for scientific ways of thinking; knowing that science, mathematics, and technology are human enterprises, and knowing what that implies about their strengths and limitations; and being able to use scientific knowledge and ways of thinking for personal and social purposes[5].

The significance of the NAEP findings for teacher educators is that this report shows deficiency in student's capacity to apply the facts they know, analyze data, assess experimental designs, and utilize specialized scientific and technologic knowledge to make conclusions. the NAEP findings suggest that existing curriculum, teaching techniques and instructional materials effectively transmit facts and rote skills to most children but fail to impart high-order thinking and learning abilities'. the increased expectations for higher level results will need instructors and indeed teacher education programs to integrate new ways of teaching, creative instructional resources, and approaches to learning and instruction[6]. These problems may offer an opportunity for technological education. Could instruction in technology education, when matched with the theoretical viewpoint from the cognitive sciences set it different from teaching methods and instructional materials that transmit facts and rote skills? Could the NAEP findings and subsequent demands for new teaching techniques offer an opportunity for technology education to convey its instructional methods to the educational community? This article explores four cognitively based models of teaching that when connected to exemplary practice in technology education may provide a strong foundation for the theoretical and practical basis of cognitive functions and instructional practice in technology education.

1.1. Traditional instruction

one of the most current and thorough examinations of American education. in general, that instructors are in charge, the center of action, and they out-talk the whole class by a ratio of three to one. Teachers were seen spending much of their time teaching or supervising pupils engaged in personalized seatwork. Observational data gathered throughout the research indicated that student passivity, individual performance, and instructor control were stressed, whereas student involvement, collaboration, and peer learning were de-emphasis[7].

there is a focus on direct teaching with strong instructor control throughout conventional educational practice. The instructor lectures and the pupils listen. There is minimal debate and little chances for pupils to express their own emotions, thoughts, concepts or concerns throughout the course of teaching[8]. In technology education, utilizing conventional methods to technology education that are not influenced by current research is just a contemporary display of teaching and learning from the 1960s. Traditional teaching methods, he argues, stress stability, predictability, and place the learner in a passive role susceptible to preset results. this manuscript seeks to focus on the potential of those engaged in technology education to focus our practice and research from within well-researched theories of learning and instruction grounded in the cognitive sciences.

1.2. A Requirement for Grounding

Through expertise in classroom teaching and improving instructional techniques by trial and error, technology educators have seen the effectiveness of hands-on, lab-based design and problem solving education. However, they have lacked a strong link or grounding between thoroughly studied ideas on learning and teaching that might assist verify their experiences and support their instructional approaches[9]. Research based on theory from the cognitive sciences may possibly offer technology instructors with a solid knowledge and basis in support of their experiences. Instruction based on the cognitive science tries to transmit the self-regulation and monitoring of cognitive processes such as memory, process, control of thinking process, reflection, appropriate application, and the cognitive tools for thinking and learning from the instructor to the student.

A central theme resonating across the cognitive science literature that is applicable to technology education is that, when instruction and instructional materials are designed, they should be designed to help students acquire and integrate the cognitive and metacognitive strategies for using, managing, assessing, reorganizing and discovering knowledge. This means that all students including technology students must be active, collaborative participants in framing technology related questions, developing and engaging in data collecting, analytic methods, and must be allowed to anticipate and ask about observed results[10].

Technology education curriculum has developed from a rich history of hands-on team-oriented, project-based learning typically linked with activities in industrial arts. These teaching techniques have for years been promoted as the strength of technology programs. Although cognitive science research has given data that may support the truth of this assertion, technology education teachers continue to rely on their anecdotal evidence, which they have gathered over time. The growing field of technology education has to concentrate on current cognitive research by embracing the chance to demonstrate the relevance and value of their programs and teaching techniques.

2. DISCUSSION

Several suggestions are directly relevant to teaching in technology from a cognitive viewpoint.

- Technology instructors must embrace the position of teacher as coach. This requires instructors to monitor and control student efforts at issue solving so they don't go too deep into the incorrect answer but enable students to have the chance to experience the complicated process and emotions of genuine problem solving and design practice.
- Technology instructors assist students learn to reflect on the methods employed when planning, building, testing, and solving issues, (learning by doing), and contrast their techniques with those used by others in the class.
- The job of the technology instructor as computer-based instructional tutor with students working in organized groups of two is not being a facilitator or coach.
- Technology instructors must learn to utilize a classroom resource that is frequently underused - other pupils. By learning to build climates that promote cooperative learning, it becomes feasible to enable students participate in active problem solving and reflection even if there is only one instructor and many students.

When reciprocal teaching is used in a design and technology class, students read a piece of expository information from a design brief, paragraph by paragraph. During the reading they learn and practice four reading comprehension techniques that may be integrated in a framework of design and problem solving in technology education:

- identification of issue sets via creating questions,
- summarizing,
- trying to explain issue, context and use of technology, and
- anticipating what feasible solutions may exist and the necessary knowledge and information required to satisfy design limitations.

During the early phases of reciprocal teaching, the instructor takes the primary responsibility for instruction by directly modeling the process of applying these techniques on a design issue. After the instructor has demonstrated, the students practice the techniques, and the teacher encourages each student's involvement via personalized feedback, further modeling, coaching, suggestions, and explanation. The instructor changes the complexity of the assignment according to the present level of the learner. The instructor demonstrates and explains, surrendering part of the work to novices only at the level each one is capable of negotiating at any one moment. Increasingly, as the beginner gets more proficient, the instructor raises his or her expectations, demanding involvement at a somewhat more difficult level.

During this guided exercise the instructor encourages students to start conversation and respond to other students' comments. Students' involvement may include

- expanding or commenting on another student's summary,
- proposing other questions,
- remarking on another's forecasts,
- seeking clarification of information, they did not comprehend, and
- assisting to settle misconceptions.

The instructor helps the pupils by rephrasing or expanding on their replies, remarks, and questions. In the course of this guided exercise, responsibility transfers progressively from the instructor performing most of the work to the learner taking over the main cognitive role while the teacher observes and assists only when required. At this point, the practice becomes a dialogue: one student asks questions, another answers, and a third comments on the answer; one student summarizes and another comments on or helps to improve the summary; one student identifies a difficult problem or design constraint and the other students help to infer possible solutions and give reasons for the inferences they made. The focus throughout is on joint effort by instructor and students to provide meaning to the concepts in the context of the technical problem, rather than simply teaching to the answer.

In addition, throughout the conversation, students are given training in why, when, and where such activities should and may be used in real settings outside the classroom. Thus, reciprocal teaching has two main characteristics. The first is teaching and practice of four comprehension-fostering strategies: question creation, summarization, prediction, and clarification. The second consists of the utilization of the reciprocal teaching dialogue as a medium for learning and applying these four techniques. While these suggestions are far from comprehensive they do offer a point of departure from which to generate debate and thought among technology teacher educators about anchoring the teaching of technology in the well-researched heritage of the cognitive sciences.

3. CONCLUSION

In summary, the design features and instructional practice seen in many outstanding technology education classrooms agree closely with the cognitive science perspective of learning, knowledge, and teaching. Specifically, effective technology education learning is in accordance with the idea that the student is an active participant in the educational process and is free to reflect, monitor, assess, and participate in self-regulation. Extensive usage of socially dispersed knowledge in the classroom and the utilization of projects in the form of student design constructs promote a collaborative classroom culture.

The ability of a student to manipulate and create design solutions, participate in collaborative projects with their peers and connect technology-based activities inside the classroom to authentic practice outside of school represent powerful evidence that learning and instruction in technology education can meet the current reform demands recommended by research on learning and instruction in the cognitive sciences. Therefore, technology education teaching must continue to concentrate on the process of learning in-doing rather than simply doing. Society today expects that students think critically, examine all alternatives, analyze and reflect on their choices and develop the process to accomplish the goal or result of the lesson.

Although technology education has developed outside from the cognitive science research tradition, it seems amazingly adapted to embrace many features of a cognitive science viewpoint at a general level and in terms of their perspectives of the learner, knowledge, and teaching. Specifically, there is significant concordance between technology education and how one may utilize cognitively based instructional paradigms such as collaborative learning, socially dispersed knowledge, design/engineering, and project based teaching to assist student understanding of technology. In technology education the acceptance of the role of the student and instructor congruent with cognitively based models/roles linked to learning and teaching are important to bridging theory into practice.

Technology education teaching demands the student to be engaged in the learning process and exert significant control in monitoring their own development in line with metacognitive theories. The job of the instructor must not be to supervise computers delivering information to tabula rasa receivers, but rather to foster the construction of and correcting often-erroneous student representations of technology via genuine application. While the instructional characteristics that make up a technology education classroom have long been known to those who practice teaching technology, the powerful connections that exist between well researched theories on learning and instruction in the cognitive sciences and technology education were often missing. Teachers of technology have long used instructional methods that have inspired and extended student learning in dynamic classroom settings. It is little surprise that many before us have long claimed that the structure of technology classrooms engages a wide variety of pupils in fascinating ways. Perhaps the link between how research is meant to inform practice might come full circle in anchoring cognition and teaching in technology education in the tradition of the cognitive sciences.

REFERENCES:

[1] D. Kember and D. Y. P. Leung, "Disciplinary Differences in Student Ratings of Teaching Quality," *Res. High. Educ.*, vol. 52, no. 3, pp. 278–299, 2011, doi: 10.1007/s11162-010-9194-z.

[2] M. Healey, "Linking research and teaching exploring disciplinary spaces and the role of inquiry-based learning," *... Between Res. Scholarsh. Teach.*, pp. 67–78, 2005.

[3] T. J. Lund and M. Stains, "The importance of context: an exploration of factors influencing the adoption of student-centered teaching among chemistry, biology, and physics faculty," *Int. J. STEM Educ.*, vol. 2, no. 1, 2015, doi: 10.1186/s40594-015-0026-8.

[4] R. Paterson, "'Because Sometimes Your Failures Can Also Teach You Certain Skills': Lecturer and Student Perceptions of Employability Skills at a Transnational University," *Qual. Res. Educ.*, vol. 6, no. 3, p. 241, 2017, doi: 10.17583/qre.2017.2583.

[5] A. Misseyanni, M. D. Lytras, P. Papadopoulou, and C. Marouli, "Active learning in higher education: a theoretical background," in *Active Learning Strategies in Higher Education : Teaching for Leadership, Innovation, and Creativity*, 2018, p. 399.

[6] R. Neumann, "Disciplinary Differences and University Teaching," *Stud. High. Educ.*, vol. 26, no. 2, 2001, doi: 10.1080/03075070120052071.

[7] M. A. De Miranda, "The Grounding of a Discipline: Cognition and Instruction in Technology Education," in *International Journal of Technology and Design Education*, 2004, vol. 14, no. 1, pp. 61–77, doi: 10.1023/B:ITDE.0000007363.44114.3b.

[8] A. Bacal Roij, "The Pedagogical Legacy of Dorothy Lee and Paulo Freire," in *Active Learning Strategies in Higher Education*, 2018, pp. 339–359.

[9] C. Marouli, A. Misseyanni, P. Papadopoulou, and M. D. Lytras, "A New Vision for Higher Education: Lessons from Education for the Environment and Sustainability," in *Active Learning Strategies in Higher Education*, 2018, pp. 361–387.

[10] A. Bell and K. Thomson, "Supporting peer observation of teaching: Collegiality, conversations, and autonomy," *Innov. Educ. Teach. Int.*, vol. 55, no. 3, pp. 276–284, 2018, doi: 10.1080/14703297.2016.1212725.