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Role of Education, Literature, Culture and Society in Global Development

on

13th & 14th November 2022

उत्तराखण्ड शासन

CERTIFICATE

This is to certifity that ~~Prof./Dr./~~Miss/~~Mr~~..... MALYANI PADHAN

of..... THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA, VADODARA *.....participated in International Seminar on "Role of Education, Literature, Culture and Society in Global Development", organized by Department of B.Ed., L. S. M. Govt. P. G. College, Pithoragarh (Uttarakhand) India, on 13th-14th November, 2022 and contributed as Chairperson/Invited Speaker/ Special Guest /presented a research paper titled,* "Perception of Odisha Government Secondary School Teachers towards Mentoring for ST- High School Transformation Programme."

Dr. A. K. Chaturvedi	Pushkar Singh Bisht	Prof. Bheema Manral	Prof. Durgesh Pant	Prof. Beena Sharma
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CERTIFICATE

This is to certify that Prof./Dr./Mr./Ms. Malyani Padhan has participated / presented a paper on: Sports Integrated Pedagogy - The Way Forward

in the National Seminar on: "Promising Face of Teacher Education: Perspectives and Practices" organized by the Department of Education, Faculty of Education and Psychology, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat on 8 - 9 February, 2023.

Prof. Satish Pathak
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Implementing Integrated STEM Education: A Delphi Study of Secondary Teacher Leaders of Odisha

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Abstract

In the modern world, there has been an increasing demand for the implementation of the integrated STEM education at the school level. Integrated STEM education makes students competent to use multiple skills to solve real-world problems. The purpose of the study was to identify the key elements of professional learning opportunities that best support the implementation of integrated STEM education at the secondary level. This study also sought to determine the degree of importance of these identified elements of professional learning opportunities. The study utilized Delphi method to elicit responses from an expert panel through telephonic interviews and electronic survey within a 2-round process. The expert panel consisted of 12 teacher leaders of the government secondary schools of Bargarh district, Odisha and they were selected by their principal based on 5 prominent characteristics of effective teacher leaders. The responses of Delphi round 1 elicited through interviews were analyzed thematically. The data collected through four-point Likert scale was analyzed through frequency, percentage, and mode. The findings revealed that there are numerous requirements of professional learning opportunities that need to be met. The expert panel members identified eight key professional learning opportunity elements for the implementation of integrated STEM education that were collaboration, mentoring, leadership skill enhancement training, resources, professional development training, networking with neighborhood colleagues, peer observation, and a safe atmosphere. In terms of the degree of importance of the identified eight elements, the expert panelists identified the need for collaboration as the most important element of professional learning opportunities. In addition to collaboration, the other key elements of professional learning opportunities i.e., mentoring, resources, and peer observation were also given importance.

Introduction

Education is an important instrument to make the future generation globally competent and represent India in the world landscape. The quality of education depends largely on the school culture, teachers' competencies, teaching approaches, infrastructure, and teaching learning materials. It also affects students' success in the academic field. In order to make students ready to solve real-world problems, the development of 21st-century skills, and life skills are needed. Teachers should develop these skills among students either through a direct approach or indirect approach to enable students to cope in this challenging world. They should be trained to solve problems of real life by thinking critically and creatively along with making the right decisions on time. The government has initiated several reforms in the sphere of education to make students ready to meet the challenges of the 21st century. National Education Policy (2020) has strongly recommended promoting holistic development in schools. The goal of education is not only promoting cognitive development but also moulding well-rounded students equipped with 21st-century skills (NEP, 2020). The attainment of this goal requires revamping and reorienting all aspects of the pedagogy and curriculum in schools at each stage of education. In this stance, Science, Technology, Engineering, and Mathematics (STEM) education serves as a potent means to promote holistic development as well as national development. Integrated STEM education is an approach to teaching that integrates two or more of the four STEM courses and uses real-world situations which in turn improve student learning. According to Sanders (2009), integrated STEM education is an "approach that explores teaching and learning between/among any two or more of the STEM subject areas, and/or between a STEM subject

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and one or more other school subjects". Disciplines are combined "based on interconnections between the subjects and real-world challenges (Moore *et al.,* 2014). Integrated STEM education makes students aware about when and how to apply the learned knowledge in real-life situations. However, it is seen that the present education system does not equip students with the required skills and competencies.

The Teaching-Learning Scenario

Nowadays, learning poverty is a barrier to students' all-round development. A simple, age-appropriate story cannot be read and understood by 53 percent of Indian children by the end of the elementary level (World Bank, 2019). In Grade 3, approximately 75% of rural students struggle to read at grade level (ASER, 2019). The NCERT report of 2022 states that 11% of students are unable to do the most basic grade-level tasks because they lack the necessary skills and knowledge. Additionally, just 37% of students possess minimum skills and knowledge and can only partially complete activities appropriate for their grade level (NCERT, 2020).

Indian students lack critical thinking abilities, hence they avoid difficulties rather than seeking solutions (Patro, 2022). In a study conducted in Mysore, India, by Sherafat and Murty (2016) including 625 students, it was revealed that 51% of students had poor critical thinking abilities, 17.60% had moderate abilities, and roughly 30.72% had strong abilities. Additionally, 74 percent of students of government schools exhibit poor critical thinking skills.

Researches have shown that pedagogy used in Indian classrooms do not improve conceptual understanding and develop thinking skills among students. Soni and Trivedi's (2018) case study on Gotirth Vidyapeeth of India revealed that traditional methodology is used by teachers to educate students. In present times students give a lot of importance to rote learning and are more exam-focused. From elementary school to college, the majority of Indian graduates are educated through rote learning (Antidote to Rote Learning-Forbes India Blogs, 2018). Thus, they cannot handle the challenges of knowledge explosion. The intellectual development of students is hampered by a lack of knowledge and abilities. In order to promote holistic development, schools should stress on enhancing knowledge, skills among students. Integrated approach to STEM can serve as an effective means to attain this goal. Integrated STEM education enables children to perform their age-appropriate tasks i.e., reading, writing, arithmetic along with developing higher order thinking skill. STEM education is an effective model for enhancing higher-order abilities among K-12 students (Zeng *et al.,* 2018). Researches have shown that STEM education issuccessful in enhancing students' academic successatknowledge, comprehension, and application levels (Ozkan & Kettler, 2022).

In order to promote holistic development nationwide, special consideration should be given to educationally backward districts all over India. An expert committee of the University Grants Commission (UGC, 2008) has recognized 18 districts out of a total of 30 districts in Odisha as educationally backward (Major Initiatives, Ministry of Education, 2021). According to this report, Bargarh is an educationally underdeveloped region of Odisha.

Students of Odisha perform poorly in competitions at the national level. In 2019, Just 1.78 percent (4360 out of 245000) of the qualifying applicants for the Indian Institute of Technology Joint Entrance Examination (IIT JEE) (Main) were from Odisha (TOI, 2019). Odisha had 575 out of 38705 (i.e., 1.49%) eligible candidates nationwide for the IIT JEE in the same year (Advanced) (TOI, 2019 & IITBBS, 2019). 2.1% (16 out of 759) of the qualified applicants for the civil service examination held by the Union Public Service Commission were from Odisha. 2.1 percent (16 out of 759) of the qualified applicants for the civil service examination held by the Union Public Service Commission were from Odisha (New Indian Express, 2019). It demonstrates how woefully unimpressive are the level of student competitiveness of Odisha at the national level. Just 31% of students in Odisha have the necessary skills for a suitable profession, according to a news article released by Patro, titled Skills India Report (2021). Odisha is not one of the Top-10 states in terms of employability.

There is a demand to improve the quality of education in Odisha. In order to promote quality education, Integrated STEM education may serve as a means. According to research, integrated STEM education increases students' participation in learning activities, which helps them develop critical 21st-century abilities. According to Korthagen (2010), implementing integrated teaching approaches encourages teachers to increase their knowledge base and spend more time on lesson planning and teaching activities to increase the effectiveness of their lessons. It provides students with the opportunities for developing higher-level thinking and problem-solving skills by facilitating student-centered and meaningful learning experiences (Stohlmann *et al.,* 2012). Students who study through the STEM approach are able to solve problems logically and use technology on their

own to come up with new ideas and inventions. Integrating STEM subjects have positive effects on the achievement, learning, and attitudes of students (Bragow *et al.,* 1995; Hurley, 2001; Becker and Park, 2011).

Additionally, research has shown that when students engage in STEM-related activities like prototyping, inventing solutions, and using technology like 3D printers, they perform better and are more motivated (Tillman *et al.,* 2014). This could be because integrated techniques make instruction seem more relevant, dynamic, demanding, meaningful, competent, and supportive to students, all of which are associated with higher levels of student engagement (Shernoff, 2013).

Professional Learning opportunities: Implementation of STEM Education

The successful implementation of integrated STEM Education highly depends upon the teacher efficacy and competencies. Teacher professional development is a stepping stone towards improving efficacy and competencies of teachers to make them ready to implement such integrated approaches in the classrooms. In this stance, professional development opportunities throughprofessional learning community, workshops, conferences, study groups, networking, and mentoring serve as effective means to do so. Falloon *et al.,* (2021) found that principals believed that the success of the STEM education depended heavily on the professional capital and collective effectiveness of the teachers. All schools strengthened teachers' competencies through professional learning by offering internal and external mentoring and training (Falloon *et al.,* 2021). Conferences, networking with distant teachers for idea exchange, peer learning and co-teaching within the classroom, and external professional development programs offered by state authorities are numerous ways through whichteachersmay engage in professional learning (Falloon *et al.,* 2021). Workshop is also an effectivemeans for professional learning (Chai, 2019). Additionally, School readiness in terms of resources and supportive culture is also needed to support teachers' growth. School transformation and reforms should also be initiated.

Odisha government initiative for the 5T high school transformation programme (Teamwork, Technology, Transparency, Transformation, and Time limit) is also helpful to implement STEM education. The 5T programme aims to prepare teachers as leaders, create confidence in the students, and prepare them for global competition. Thus, it takes steps to transform the educational environment of all government and government-affiliated high schools by equipping them with modern technology, digital and smart classrooms, e-libraries, and laboratories. Apart from this, the elements needed for successful implementation of integrated STEM education are to be identified at ground level to transform an educationally backward district (i.e., Bargarh district) into an educationally advanced district. Therefore, it is essential to study the professional learning opportunities that support the implementation of integrated STEM education.

The purpose of this study was to identify theelements of professional learning opportunities that support the implementation of integrated STEM education at the secondary level. This study also sought to determine the degree of importance of these identified elements of professional learning opportunities.

Research Design

As a qualitative research design, the Delphi method was used in this research study. A philosophical approach termed phenomenology, which focuses on people's experiences from their point of view, allowed the researchers to gather descriptive data (Roberts, 2010, p. 143). McMillan and Schumacher (2010), claimed that this research design "assesses the nature of current conditions" and "allows for defining something as it is". There are three kinds of Delphi methods that can be used to "produce a detailed investigation of a topic and/ or problem," and they are the "Policy Delphi Model, the Trend Model, and the Structural Model" (Stitt-Gohdes and Crews (2004) . This study used the policy Delphi approach, which "attempts to uncover the most solid arguments for and against various policy issue resolutions" (Stitt-Gohdes & Crews, 2004, p.3). Members of the expert panel respond to the same research questions during each round of the Delphi in this design.The researcher gathered and analyzed the responses of the first round and the results of the first round were utilized to construct the next round of questions for the expert panel members to respond.

Sample

The sample for the present study was selected by purposive sampling technique. Effective high school teacher leaders of the Bargarh district of Odisha were identified. The high school principals were requested to recommend two to three teachers who met the criteria for effective teacher leaders. The five most important attributes for successful teacher leaders identified in the

literature review served as the criteria used by high school principals to chooseteacher leaders i.e., 1) Embody and convey the idea that teachers provide a positive effect (Collay, 2011), 2) Establish professional learning communities through open communication and deliberate action (Marzano *et al.,* 2005), 3)Strive for educational excellence and advancement by lifelong learning (Reeves, 2008), 4)Focus on the needs of all students to address cultural barriers inside the organization (Katzenmeyer & Moller, 2009), 5)Create networks and mechanisms of support at all organizational levels to put ideas into action (Crowther, 2009).

25 secondary teachers were identified as potential participants for the research study by 15 secondary school principals of Bargarh district. A letter of consent for participation was sent to each of the 25 teachers from 15 government high schools of Bargarh district of Odisha. For each of the two rounds, 12 teachers who had given their agreement to participate as members of the expert panel and were taken. Therefore, the final sample consisted of 12 effective high school teacher leaders from Bargarh district in Odisha.

Instrument

Researchers have constructed unstructured interview schedule to collect data pertaining to the elements of professional learning opportunities that support the implementation of integrated STEM education at the secondary level. Telephonic interviews were conducted with teacher leaders in the first round of the Delphi survey. Responses to the first-round question was analyzed and utilized to construct a four-point Likert scale. The Likert-scale has options as, not at all important (1), somewhat important (2), moderately important (3), and very important (4). In this Likert-scale, effective teacher leaders were asked to rate the degree of importance of the responses of Round 1.

Data Analysis

Delphi rounds were used to present data collection results. The responses of questions addressed in each of the two rounds, were analyzed qualitatively and quantitatively. The responses of Delphi round 1 elicited throughinterviews were analyzed thematically. The data collected through Likert scale was analyzed through frequency, percentage, and mode.

Delphi Round I: Question

One open-ended question was used in the first round of the Delphi survey in order to elicit a wide range of responses. Twelve teacher leaders who formed the group of experts panel responded to the telephonic interviews. The question of round 1 was as follows:

1. What elements of professional learning opportunities support the implementation of integrated STEM education at the secondary level?

In Round 1 of the Delphi method, responses to the first question were extracted and thematically aggregated based on the components of professional learning opportunities. These responses are given in Table-1.

Table-1: Elements of Professional Learning Opportunities that Support Integrated STEM Education

Highlighted Elements	Frequency of response
Collaboration	10
Mentoring	7
Leadership skill enhancement training	6
Resources	8
Professional development training	8
Networking with neighborhood Colleagues	4
Peer observation	1
A safe atmosphere	4

N=12

As shown in Table 1, expert panel members identified eight essential components of professional learning opportunities that support the implementation of integrated STEM education: collaboration, mentoring, leadership skill enhancement training, resources, professional development training, networking with local colleagues, peer observation, and a safe environment. Collaboration (10 out of 12), resources (8 out of 12), professional development training (8 out of 12), and mentoring (7 out of 12) were the four elements of professional learning opportunities that were most frequently identified as best supporting elements for the implementation of integrated STEM education. Additionally, out of 12 teachers, 6 teachers stated leadership skill enhancement training, 4 teachers emphasized on networking with neighborhood colleagues,1 teacher stated peer observation and 4 teachers stated a safe atmosphere is needed for the implementation of integrated STEM education.

Delphi Round 2: Question

The question for Delphi Round 2 was "To what

degree are the elements of professional learning opportunities identified in Round 1 important in implementing integrated STEM education"? First-round responses were analyzed and sorted into items for a Likert scale.Expert panelists who participated in Round 1 were asked to rate the significance of the top eight responses of Round 1 during Round 2.

The expert panel was surveyed via an electronic scale. These responses are presented in Table-2.

Table-2: The Degree of the Elements of Professional Learning Opportunities that Best Support the Implementation of Integrated STEM Education

Identified Elements for Professional learning opportunity	Not at all Important	Somewhat Important	Moderately Important	Very Important	Mode
	Frequency(%)	Frequency(%)	Frequency(%)	Frequency(%)	
Collaboration	0(0%)	1(8.3%)	5(41.7%)	6(50%)	4
Mentoring	0(0%)	1(8.3%)	4(33.3%)	7(58.33%)	4
Leadership skill enhancement training	0(0%)	0(0%)	7(58.33%)	5(41.7%)	3
Resources	2(16.6%)	1(8.3%)	4(33.3%)	5(41.7%)	4
Professional development training	1(8.3%)	0(0%)	6(50%)	5(41.7%)	3
Networking with neighborhood colleagues	2(16.6%)	1(8.3%)	4(33.3%)	5(41.7%)	4
Peer observation	2(16.6%)	2(16.6%)	5(41.7%)	3(25%)	3
A safe atmosphere	2(16.6%)	3(25%)	4(33.3%)	3(25%)	3

N=12

As shown in Table 2, the expert panelists ranked the requirement for collaboration (mode=4) as the most crucial component of professional learning opportunities. In addition, networking with local coworkers (mode=4), resources (mode=4), and mentorship (mode=4) were also significant components of professional development opportunities. Another four elements that support professional learning opportunities for implementation of integrated STEM education were leadership skill enhancement training(mode=3), professional development training (mode=3), peer observation (mode=3), and a safe environment (mode=3).

Result and Discussion

Delphi I

In response to the question of Delphi round I i.e., "What elements of professional learning opportunities that support the implementation of STEM education"?, the expert panel members identified eight key professional learning opportunity elements for the implementation of integrated STEM education and the elements were collaboration, mentoring, leadership skill enhancement training, resources, professional development training, networking with neighborhood colleagues, peer observation, and a safe atmosphere. The teacher leaders strongly emphasized on four elements for the implementation of integrated STEM education. The elementsincluded collaboration, resources, professional development training, and mentoring. These findings are consistent with Shernoff *et al.,* (2017) who found that the supports needed to advance integrated STEM were time to collaborate and plan, teacher professional development, supportive stem ethos/culture, communication between departments, more instructional time, resources, shift in teacher attitudes, more manageable class size. It is believed every teacher has expertise in their own subject but effective implementation of integrated STEM education demands that teachers need to have mastery in each STEM subject. Therefore, teachers need to be supported to implement the integrated approach. Since an integrated approach focuses on big ideas that are interconnected and interrelated, support is required to aid teachers with instructional approaches that organize knowledge around significant ideas, concepts, and themes (Stohlmann *et al.,* 2012).

It was found that teachers desired to participate in professional development programs that focused on STEM approaches. In general, the teachers we interviewed with had an idea of how to begin teaching using the integrated STEM approach, but they also acknowledged that they needed support, including more cooperation and training, more role models, and more

mentoring. A teacher stated the need to see classroom of other expertteachers, who adopted integrated STEM approach in their classroom. Through the observation of sample lessons, teachers comprehend how curriculum was transacted i.e., instructional method, interaction with students through the integrated approach. The literature on the best techniques in teacher professional development commonly identifies watching rich instances of classroom interactions, including both film and live observations, to efficiently structure instructors' sense-making (Ball *et al.,* 2009; Borko *et al.,* 2008; Roth *et al.,* 2011; Sherin and Han, 2004).

Delphi II

In response to the question of Delphi round II i.e., "To what degree are the elements of professional learning opportunities identified in Round 1 important in implementing integrated STEM education"?, the expert panelists indicated that the most crucial component of professional learning opportunities was collaboration. Mentoring, resources, and networking with local coworkers were additional crucial components of professional learning opportunities for the implementation of integrated STEM education at the secondary level. They emphasized that the four elements that support professional learning opportunity were leadership skill enhancement training, professional development training, peer observation, and a safe atmosphere. This is consistent with the findings of Shernoff *et al.* (2017), who found that teachers indicated their need and desire for time to work with other teachers. Successful STEM integration depends heavily on collaboration between teachers from many disciplines. In order to build multidisciplinary, integrated approaches and expand their grasp of other subject areas, teachers felt that collaboration with other teachers from different disciplines was crucial (Shernoff *et al.,* 2017). Stohlmann *et al.* (2012) also found that support is required to assist teachers with instructional approaches that organize information around major ideas, concepts, and themes since an integrated approach focuses on big ideas that are connected and interrelated.

Conclusion

Integrated STEM education demands competent and expert teachers, who have expertise in more than one subject. The requirement of teachers to attain mastery in STEM subjects needs to be fulfilledon an urgent basis. Learning opportunities should be provided to teachers both inside and outside schools for the constant development of their skills and competencies for successful implementation of integrated STEM education. The Odisha government initiative in the form of 5t high school transformation programme is just a helping hand, not enough for the implementation of such an integrated approach. As the findings revealed that the secondary teachers required more support, the Odisha government should take more initiatives to provide the needed support to teachers for the effective implementation of integrated STEM education at secondary schools of Bargarh district.

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