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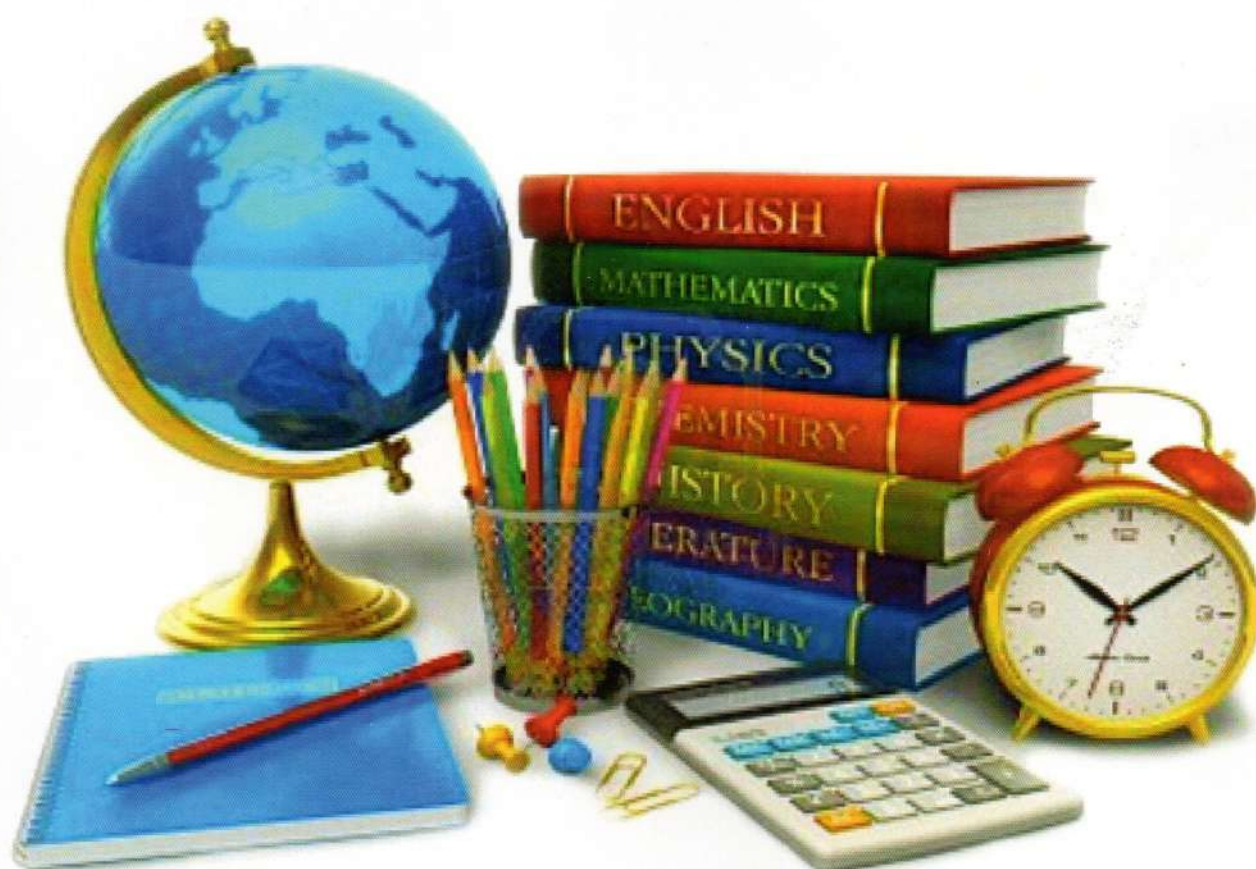
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DIGITAL INTELLIGENCE: REVOLUTIONIZING THE TEACHING-LEARNING PARADIGM

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ABSTRACT

In education, the imperative integration of cutting-edge technologies has emerged to meet the evolving needs of 21st-century learners. Standing on the brink of the fourth industrial revolution, which amalgamates digital, biological, and physical realms, the educational paradigm is undergoing profound transformation. In our ever-changing world, where constant adaptation is necessary, education cannot be approached with a one-size-fits-all mentality. It is crucial to provide diverse platforms that cater to the individual needs of students. Online learning offers personalized education, self-directed learning, and easily accessible learning tools. Artificial intelligence (AI) introduces new tools to the educational environment with the potential to transform conventional teaching and learning processes. This study offers a comprehensive overview of AI technologies, their potential applications in education, and the difficulties involved. In addition to the advantages of cutting-edge chatbots like ChatGPT, their use in education raises important ethical and practical challenges. The authors aim to provide insightful information on digital intelligence in education, Artificial Intelligence in Education 4.0 and 5.0, challenges and solutions to adapt the technology in education.

Keywords: artificial intelligence, personalized education, self-directed learning

Introduction

Digital intelligence refers to the ability of individuals and systems to effectively understand and utilize digital technologies, data, and tools to enhance decision-making, communication, and problem-solving processes. It encompasses a range of skills, including digital literacy, data analysis, artificial intelligence (AI), and machine learning. These are aimed at improving efficiency and innovation across sectors such as education business, and healthcare. In the educational context, digital intelligence allows for a more personalized, adaptive, and interactive learning

environment by automating administrative tasks, enhancing student engagement, and fostering critical thinking and problem-solving through technologies like AI-based tutoring systems (Duffy, 2021).

The Rise of Digital Intelligence in Education

The increasing adoption of digital technologies has fundamentally transformed the education sector. Digital intelligence, a core component of this transformation, refers to the effective use of digital tools and platforms for teaching and learning. The COVID-19 pandemic accelerated this shift, embedding digital intelligence at the heart of

modern education (Bates, 2020). As a result, educational methods have evolved, allowing personalized learning experiences where AI-powered platforms assess individual learning patterns and adapt content accordingly (Williams & Adams, 2021). This change promotes knowledge retention and equips students with essential future skills, including critical thinking, problem-solving, and adaptability.

Moreover, digital intelligence empowers educators by automating repetitive tasks, such as grading and attendance tracking. Tools like Learning Management Systems (LMS) streamline communication and resource management, enabling educators to focus on teaching and mentorship (Roberts & Tanner, 2020). While the benefits of digital intelligence in education are clear, several challenges impede its widespread application. A significant barrier is the digital divide; students from disadvantaged backgrounds often lack access to essential technologies, exacerbating inequalities in educational opportunities (Smith & Johnson, 2022). Additionally, data privacy concerns arise as digital platforms collect vast amounts of student information, necessitating robust ethical frameworks to ensure responsible use of such data (Doe & Kim, 2021).

Digital Literacy and Information Management

In the digital age, the ability to search, evaluate, and interpret information has become an essential skill. However, despite the convenience of digital platforms, the process of extracting accurate information is often complex. Digital literacy

involves more than just using digital tools; it also includes the ability to assess the reliability and accuracy of information found online (Topal & Suner, 2020). Research shows that students employ different strategies when seeking information in digital environments, making it crucial to teach them effective digital literacy skills (Zhou & Lam, 2019). Teachers with strong digital literacy skills can guide students in navigating the digital world, helping them verify information sources and apply critical thinking (Boyacl, 2019).

Artificial Intelligence in Education 4.0

Education is on the cusp of a technological revolution with the integration of AI and emerging technologies in what is known as Education 4.0. This era builds upon previous phases: Education 1.0 (traditional classroom), Education 2.0 (introduction of computers), and Education 3.0 (web-based learning). Education 4.0 emphasizes dynamic, personalized learning experiences supported by AI, big data, and the Internet of Things (IoT) (Bates, 2020). AI plays a transformative role in personalized learning by analyzing vast datasets to tailor content to individual students' learning styles and progress (Williams & Adams, 2021). Furthermore, AI-powered tutoring systems provide real-time feedback and support, enhancing student and learning outcomes.

Key Applications of AI in Education

- *Personalized Learning:* AI systems enable personalized learning by adapting to students' preferences, strengths, and learning styles. Adaptive platforms dynamically adjust lesson

difficulty and pace based on individual progress, optimizing both understanding and retention (Bates, 2020).

- *Intelligent Tutoring Systems:* These AI-powered systems offer real-time guidance and additional resources based on student performance, fostering a more engaging and efficient learning experience (Roberts & Tanner, 2020).
- *Automation of Administrative Tasks:* AI streamlines administrative responsibilities, such as grading and attendance, allowing teachers to focus on instruction and student mentorship (Smith & Johnson, 2022).
- *Curriculum Development:* AI analyzes educational data to identify gaps in curricula, helping educators create more relevant and effective teaching materials (Doe & Kim, 2021).
- *Gamification and Interactive Learning:* AI integrates with educational games, adapting scenarios to individual progress, which enhances motivation and engagement in learning (Williams & Adams, 2021).

The Integration of Artificial Intelligence (AI) in Education

It marks a profound shift from traditional methods towards Education 4.0 and the emerging Education 5.0. AI transforms learning environments by making them more interactive, flexible, and student-centric, offering personalized experiences tailored to each learner's needs and preferences. Artificial Intelligence (AI) technologies have brought about significant transformations in education, particularly in the realm of personalized learning. AI-powered personalized learning tailors

educational experiences to meet the unique needs, preferences, and abilities of individual students (Brown & Smith, 2020., & Jones, 2021). By recognizing the diversity in learning styles and paces, AI helps create adaptive and customized learning environments that cater to each student's strengths and areas for improvement (Doe & Kim, 2021).

AI's ability to analyze vast amounts of data allows for real-time adjustments in teaching strategies and content delivery, ensuring that students receive the most relevant and effective learning materials. This fosters greater engagement and knowledge retention while empowering students to learn at their own pace, leading to improved educational outcomes (Roberts & Tanner, 2020).

Despite the numerous benefits of integrating Artificial Intelligence (AI) into education, several challenges must be addressed to maximize its potential. These challenges include concerns about data privacy, the digital divide, and the need for comprehensive teacher training.

Challenges and Solutions

Data Privacy and Security Challenges: The use of AI in education involves the collection and analysis of vast amounts of student data, raising significant concerns about privacy and security (Smith & Johnson, 2022). Ensuring that this data is used ethically and protected against breaches is critical for maintaining student trust and safeguarding sensitive information. Implementing robust data security measures is essential. This includes developing and enforcing comprehensive privacy frameworks that govern how data is collected,

stored, and used. Policies should include data anonymization, encryption, and stringent access controls to ensure that student information is handled responsibly and securely (Doe & Kim, 2021).

The Digital Divide

Challenge: The digital divide remains a significant issue, with disparities in access to technology and internet connectivity affecting students from underprivileged backgrounds (Jones, 2021). This gap can hinder the equitable application of AI, leading to unequal learning opportunities and exacerbating educational inequalities.

Solution: Addressing the digital divide involves ensuring equitable access to technology and digital resources. This can be achieved by investing in infrastructure improvements, providing affordable or subsidized technology to underserved communities, and designing AI platforms that are accessible across different devices and internet speeds (Smith & Johnson, 2022).

Teacher Training and Professional Development

Challenge: Effective integration of AI tools in the classroom requires that educators have the necessary knowledge and skills. Without proper training, teachers may struggle to use AI technologies effectively, limiting their potential benefits (Williams & Adams, 2021).

Solution: Providing targeted professional and training programs for teachers is crucial. These programs should focus on equipping educators with the skills to use AI tools effectively, understand their applications, and integrate them into their

teaching practices. Support should also include resources and ongoing assistance to help teachers adapt to new technologies (Roberts & Tanner, 2020).

Inclusive Design

Challenge: AI platforms need to be designed inclusively to cater to a diverse range of learners, including those with disabilities or from marginalized backgrounds. Without inclusive design, there is a risk that these technologies may not serve all students equitably (Brown & Smith, 2020).

Solution: Developing AI tools with inclusive design principles ensures that they accommodate diverse learning needs. This includes creating user-friendly interfaces, providing accessibility features, and ensuring that content is adaptable to different learning styles and needs. Additionally, involving diverse stakeholders in the design process can help address various accessibility concerns and promote equity (Doe & Kim, 2021).

Education 5.0 and Future Prospects

Education 5.0 advances the integration of AI by promoting a symbiotic relationship between human intelligence and AI. This phase envisions a more immersive and interactive learning environment through technologies such as augmented reality (AR) and virtual reality (VR).

Immersive Learning Experiences: By integrating AR and VR, Education 5.0 creates dynamic learning environments where students can engage with content in three-dimensional spaces. These technologies enhance understanding by providing interactive and experiential learning opportunities

that go beyond traditional methods (Roberts & Tanner, 2020).

Enhanced Skills Development: AI plays a critical role in developing essential 21st-century skills, such as creativity, critical thinking, and problem-solving. AI-driven tools and platforms help students cultivate these skills by offering personalized feedback, adaptive learning pathways, and opportunities for creative exploration (Williams & Adams, 2021).

Equitable and Inclusive Education: As AI technologies continue to evolve, ensuring that they are used in a way that promotes fairness and inclusivity remains paramount. This involves ongoing efforts to address ethical considerations, ensure transparency, and develop AI tools that cater to all learners, regardless of their background or abilities (Smith & Johnson, 2022).

Conclusion

Digital intelligence, particularly through AI, is revolutionizing education by providing personalized learning experiences and automating administrative tasks. However, challenges like the digital divide and data privacy concerns must be addressed to fully leverage its benefits. As education progresses toward Education 5.0, where human intelligence and AI work symbiotically, the potential for digital intelligence to enhance creativity, critical thinking, and problem-solving skills is vast. While AI in education presents remarkable opportunities for enhancing personalized learning and educational outcomes, addressing challenges related to data privacy, digital equity, teacher training, and inclusive design

is essential. By proactively tackling these issues, educational institutions can leverage AI to create a more effective, engaging, and equitable learning environment, paving the way for the future of Education 5.0. The future of education lies in the balance of technology and human ingenuity. AI-driven Education 4.0 and 5.0 promise to revolutionize learning, making it more personalized, efficient, and inclusive. However, addressing challenges related to access, privacy, and teacher preparedness will be key to unlocking the full potential of AI in education.

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CRITICAL THINKING AND ACHIEVEMENT MOTIVATION OF HIGH SCHOOL STUDENTS

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ABSTRACT

Critical thinking predicts a person's ability to consider from different points of view and to judge the causes of certain phenomena. It includes both logical thinking and the ability to ask questions. Developing critical thinking skills is an essential aspect of education as it is believed that it can lead to higher academic achievement. The present study on the critical thinking and achievement motivation of high school students was done using survey methodology. Critical thinking inventory and achievement motivation scale were utilized to measure the level of critical thinking and achievement motivation of high school students in order to find out the relationship between them. The study concluded that the 'γ' test indicated a significant relationship between critical thinking and achievement motivation as well as a significant relationship between critical thinking and achievement motivation of male and female students.

Keywords: critical thinking, achievement motivation, inquisitiveness, cognitive maturity.

Introduction

The teaching-learning process has undergone a tremendous change. Gone are the days when students totally depended on classroom teaching for acquiring knowledge. But today students learn by engaging themselves in outside classroom activities such as doing project work, writing assignments and doing field work. Such type of learning presupposes that students have a certain level of mental ability and intellectual maturity students who have a certain level of critical thinking and achievement motivation are believed to succeed not only in their academic field but also in all the endeavours they undertake. Therefore, it is essential to conduct a study on these two traits, critical thinking and achievement motivation.

Critical Thinking

Many scholars have attempted to define critical thinking. Bayer, (1985) held the view that critical thinking consists of the ability of person to gather and evaluate useful information. According to Hudgins and Edelman, (1989), critical thinking consists of stating evidence to justify one's conclusions and demanding evidence for accepting others' conclusions. Thus, a person with the ability to think critically is capable of raising valid questions, collecting appropriate information and evaluating them to arrive at a trustworthy conclusion about the environment which enables him/her to survive successfully.

The human race has consistently progressed mainly because it has learned over the years to be more and

more analytical, improve the ability to solve problems, rationalize and think critically. Therefore, they succeeded in embracing the technological world which was a mere fantasy to their forefathers. Thus, society became technologically complex on account of the critical evolution of the information that was made available to humanity. Thus, critical thinking consists in identifying the source of information, analyzing it effectively finding out its consistency with their knowledge and drawing valid conclusions (Linn, 2000).

Achievement Motivation

A strong compulsion to achieve excellence is called achievement motivation. It motivates the individuals to accomplish the given task to the best of their ability. It is one's ardent desire to achieve success and after success of the aspiration of human life. A person's inner drive to succeed can influence the performance of a person and thereby indicate his/her competence. Such motivation affects human behaviour according to different milieu. A person's motivation for achievement may range from fulfilling one's, biological needs to creative aspiration or accomplishing something better than the others. Motivation is essential because it affects our day-to-day life. Our desire to excel, our ability to evaluate and our efforts to succeed are influenced by our inner motivation. Thus, achievement motivation is nothing but a latent disposition that gets manifested when a person realizes that performance is an instrument essential for one's accomplishment (Mangal, 2009).

General Objectives

The general objectives of the study were to find out the level of critical thinking and the achievement motivation of high school male and female students. The second objective was to find out the relationship between critical thinking and achievement motivation of high school male and female students.

Delimitations of the study

This study was limited only to the high school students in twenty schools in Tamil Nādu. The sample was delimited to 500 high school students studying in only seven high schools and thirteen higher secondary schools in the Tirunelveli district.

Method of Study

A survey method was employed to study the critical thinking and achievement motivation of high school students. The investigator used personal data form, Critical Thinking Inventory (CTI) with the dimensions of truth-seeking, open-mindedness, analyticity, systematicity, self-confidence, inquisitiveness and cognitive maturity and Achievement Motivation Scale (AMS) with the five dimensions of accomplishment, power, recognition, affiliation and strength. Both tools were validated by Arockiasamy M.S. Selvaraj. A questionnaire for measuring variables such as Critical Thinking and Achievement was prepared and distributed among the students to elucidate their responses.

Review of Related Studies

Jeyantha Mary and Devasahayam Selvakumar

(2013) revealed that the level of critical thinking dispositions of higher secondary students was average but however, but there was a significant difference in critical thinking disposition among boys and girls, students studying in Tamil and English medium. Maheshwari and Francisca (2013) revealed that private school children were more creative than their counterparts such as children from government schools and government-aided schools.

Girija Srinivasalu (2012) revealed the superiority of the inquiry-oriented approach over the traditional method. Geeta Prabha and Indira Dhull (2012) revealed that girls possessed a higher amount of words, expressive fluency, spontaneous flexibility and originality than boys. Arun George (2011) revealed that there existed no significant difference between sub-samples (based on gender) of higher secondary teachers in reflective thinking with respect to teacher effectiveness. Harish and Sri Kantaswamy (2011) stated that teachers played a vital role in fostering skills in critical thinking, understanding complex concepts and building methods to evaluate knowledge. Jotika Gupta (2011) revealed that subjects with average psychoticism and high psychoticism scored significantly higher than the subjects with low psychoticism. Sibichen and Annaraja (2010) revealed that significant difference existed between graduate and post-graduate students in their critical thinking skills.

Rajesh Shirasth (2013) revealed that child labour and regular school-going students differed from

each other significantly on achievement motivation. Santosh Kumar Mishra & Sangeeta Jain (2013) found out that gender difference did not indicate a significant difference in their academic achievement. Nasreem Qusar (2013) indicated that neither was there any significant difference in the depression level of both low and high motivation of the male and female secondary school students.

Komalavalli (2013) revealed that there was no significant difference between male and female students in intrinsic and extrinsic motivation and between students studying in government and government-aided higher secondary schools in intrinsic and extrinsic motivation. However, there existed a difference between the students studying in Tamil and English medium in extrinsic and their overall motivation. Vishali Carriappa et al (2013) revealed that there was a significant difference among teachers of Aided, CBSE, Matriculation and Anglo-Indian schools in their level of job satisfaction and motivation.

Ambedkar (2012) stated that the vast majority of higher secondary students had very high levels of both achievement motivation and achievement in English. Arjinder Singh (2012) revealed that achievement motivation had the strongest indirect effect on emotional intelligence. Rama and Nirmala Devi (2011) revealed that in self-acceptance, the adolescent students significantly differed with respect to age and residential area, but no significant difference was noted with respect to gender. As far as achievement motivation was concerned, the adolescent students differed

significantly with respect to residential areas, but no significant difference was noted in the case of age and gender.

Thanalakhsmi et al. (2011) revealed that the achievement motivation of students of the fishermen community in general and the different dimensions were found to be moderate. English medium students and Matriculation school students were found to have better achievement motivation than their counterparts. Godwin & Krishna Prasad (2010) revealed that the self-esteem of socially challenged higher secondary students seemed to have exerted a significant influence on the development of achievement motivation. Johnson R, (2010) revealed that there was a significant difference on achievement motivation between SC/SC and non-SC/ST employees and no difference in job satisfaction among the group.

Analysis of data

Table.1.Level of Critical Thinking of High School Students.

Dimensions of Critical Thinking	Low		Moderate		High	
	N	%	N	%	N	%
Analyticity	83	16.6	345	69.0	72	14.4
Self-confidence	69	13.8	365	73.0	66	13.2
Inquisitiveness	81	16.2	336	67.2	83	16.6
Cognitive maturity	91	18.2	343	68.6	66	13.2
Open-mindedness	77	15.4	341	68.2	82	16.4
Systematicity	89	17.8	337	67.4	74	14.8
Truth seeking	66	13.2	372	74.4	62	12.4
Critical thinking	72	14.4	345	69.0	83	16.6

Table.2.Level of Critical Thinking of High School Students with Respect to Gender

Dimensions of Critical Thinking	Category	Low		Moderate		High	
		N	%	N	%	N	%
Analyticity	Male	42	15.5	184	67.9	45	16.6
	Female	41	17.9	161	70.3	27	11.8
Self-confidence	Male	40	14.8	193	71.2	38	14.0
	Female	29	12.7	172	75.1	28	12.2
Inquisitiveness	Male	50	18.5	181	66.8	40	14.7
	Female	31	13.5	155	67.7	43	18.8
Cognitive maturity	Male	52	19.2	193	71.2	26	9.6
	Female	39	17.0	150	65.5	40	17.5
Open-mindedness	Male	41	15.1	191	70.5	39	14.4
	Female	36	15.7	150	65.5	43	18.8
Systematicity	Male	53	19.6	178	65.7	40	14.7
	Female	36	15.7	159	69.4	34	14.9
Truth seeking	Male	39	14.4	205	75.6	27	10.0
	Female	27	11.8	167	72.9	35	15.3
Critical thinking	Male	43	15.9	192	70.8	36	13.3
	Female	29	12.7	153	66.8	47	20.5

Table.3.Level of Achievement Motivation of High School Students.

Dimensions of Achievement Motivation	Low		Moderate		High	
	N	%	N	%	N	%
Accomplishment	75	15.0	369	73.8	56	11.2
Power	269	53.8	133	26.6	98	19.6
Recognition	92	18.4	329	65.8	79	15.8
Affiliation	86	17.2	346	69.2	68	13.6
Strength	83	16.6	340	68.0	77	15.4
Achievement motivation	64	12.8	347	69.4	89	17.8

Table.4.Level of Achievement Motivation of High School Students with Respect to Gender.

Dimensions of Achievement Motivation	Category	Low		Moderate		High	
		N	%	N	%	N	%
Accomplishment	Male	51	18.0	201	75.0	19	7.0
	Female	24	10.5	168	73.4	37	16.2
Power	Male	180	66.4	63	23.2	28	10.4
	Female	89	38.9	70	30.6	70	30.5
Recognition	Male	69	25.5	177	65.3	25	9.2
	Female	23	10.0	152	66.4	54	23.6
Affiliation	Male	57	21.0	186	68.6	28	10.4
	Female	29	12.7	160	69.9	40	17.4
Strength	Male	56	20.7	19	69.7	26	9.6
	Female	27	11.8	151	65.9	51	22.3
Achievement motivation	Male	45	16.6	202	74.5	24	8.9
	Female	19	8.3	145	63.3	65	28.4

Table.5.Relationship Between Critical Thinking and Achievement Motivation of High School students

N	ΣX	ΣY	ΣX^2	ΣY^2	ΣXY	Calculated 'r' value	Remarks at 5% level
500	112617	71665	26120363	10528229	16343512	0.4592469	S

(At 5% level of significance, for 498 df the table value of 'r' is 0.098)

Table.6.Relationship between Critical Thinking and Achievement Motivation of Male High School Students

Male	ΣX	ΣY	ΣX^2	ΣY^2	ΣXY	Calculated 'r' value	Remarks at 5% level
271	60210	37116	13802174	5191972	8344754	0.458239	S

(At 5% level of significance, for 269 df the table value of 'r' is 0.098)

Table.7.Relationship between Critical Thinking and Achievement Motivation of Female High School Students

Female	ΣX	ΣY	ΣX^2	ΣY^2	ΣXY	Calculated 'r' value	Remarks At 5% level
229	52407	34549	12318189	5336257	7998758	0.459494	S

(At 5% level of significance, for 227 df the table value of 'r' is 0.098)

Findings

The 'r' test indicated a significant relationship between critical thinking and achievement motivation as well as a significant relationship between critical thinking and achievement motivation of male and female students.

Recommendations

After assessing the findings of the present study, the investigator recommends that the teachers should be given special training to acquire the skills of fostering critical thinking and achievement motivation among their students. Seminars and symposiums can be conducted for the parents to motivate their children. The school administration makes it a point to constantly monitor the progress

of students' progress in their creative thinking and scientific thinking and organize regular co-curricular activities which help the students to develop their creative talents and cognitive abilities.

The school curriculum should provide theoretical as well as practical knowledge in order to make it not only mark-oriented but also life-oriented. Soft skills and life skills have to be incorporated into the teaching-learning process in the schools. Students' evaluation needs to be based on overall growth not just based on their academic performance.

Twenty per cent of the school curriculum should be based on imparting vocational education and students are engaged in regular community service programs. Vocational guidance is to be introduced from high school onwards. Value education should get equal importance in the school curriculum. Teacher education has to prepare competent teachers in order to impart qualitative education and they are urged to undertake research projects on the present-day educational programme. The school curriculum needs to be revised once in five years. Senior teachers, principals, experts in education students and educational psychologists should be part of the curriculum framing committee. The prospective teachers have to be trained in the art of teaching and giving guidance. Equal importance should be given to the girl-child at all levels of education. Government schools should be better monitored in order to impart quality education and more special schools should be opened for gifted children.

Conclusion

Critical thinking and achievement motivation are two sides of the same coin. The school students should be trained in the skill of critical thinking so that they develop objectivity in their thinking and functioning in society. Achievement Motivation is essential for them as they have to have the willpower to withstand the pressure of academic requirements in order to be knowledgeable and competent in their chosen fields. Hence school education has to nurture these skills for which the teachers also get an opportunity to get trained in the art of critical thinking and achievement motivation.

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MULTIDISCIPLINARY APPROACHES IN THE 21ST CENTURY EDUCATION OF TEACHING AND LEARNING PROCESS

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ABSTRACT

In the 21st century, many problems and challenges faced by mankind can't be solved without the understanding of many disciplines and a broad and advanced education is necessary to solve the diverse contemporary challenges. Nowadays the fields of study across traditional boundaries connecting all the academic disciplines have emerged in the universities. The present study reveals the urgent need for multidisciplinary approaches in education towards teaching and learning and also emphasizes the fact that dynamic knowledge construction is the way to social revival. A descriptive methodology is carried out in this study and by introducing multidisciplinary approaches in the field of education, the students would be empowered, augmenting the potentiality of human resources and paving the way for accelerating the process of social, economic, moral, self, aesthetic, sustainability, inclusive, etc. The presentation by examining the compelling reasons for implementing multidisciplinary approaches in the education field brings out the possibilities of promoting multidisciplinary and interdisciplinary. Learning and teaching methods and the present study strongly emphasizes that multidisciplinary learning and teaching process uplifts the standard of 21st-century education which in turn brings radical changes in the societal context. It finally points out the difficulties of implementing multidisciplinary approaches in the education sector at all levels and suggests strategies for successful implementation and practices.

Keywords: approaches, barriers, curriculum, education, interdisciplinary, multidisciplinary, strategies

Introduction

In the fast-moving world of today marked by tremendous scientific, technological, and advancement, the fields of study across traditional boundaries have emerged and the curricular concept of connecting academic subject areas has got significant attention in recent years. In the modern world, we are dealing with many problems and challenges beyond the scope of a single discipline and there is a need for individuals to find solutions to a variety of challenges. Research and case studies reveal that to overcome these challenges, a multidisciplinary education approach

is a must. In the first instance, nature and society are complex, and innate curiosity to understand the elements and forces within them requires examination from the perspective of multiple disciplines. One of the burning issues in the field of any education system today is an effective pedagogic practice to enhance learning. Seminars, workshops, conferences, etc. have been conducted by educational scholars around the whole world to find out appropriate approaches to delivering content to students in order to bring about the desired changes also, educators all over the world continuously search for quality methods and

approaches of teaching and learning of subjects at all levels. With urgent calls in recent years for schools, colleges, universities, etc. to take up the role of educating all students and to re-connect to their mission to serve the public good and social empowerment, a multidisciplinary approach has emerged as a form of pedagogy especially in all the fields of education to improve student's critical thinking skills, communication skills, appreciation of diversity, understanding of social responsibility, etc. and any sustainable improvement in the human condition now requires an integrated and interactive mix of sciences, engineering, social sciences, and humanities. (Rosalind Williams, 2007) New knowledge and innovations increasingly emerge in the interface of different disciplines and the cooperation networks between different fields of education, research and working life will have an even more significant role which made the need for crossing the disciplinary and unit boundaries and combining the resources and know different fields more topical. (Gibbons et al., 1994) To respond to the more complex problems present in the information communication technology society, all education institutions are strengthening collaboration between different disciplines lowering the boundaries between different fields of study and crossing the boundaries between the different fields of 21st century study thus becoming essential.

Objectives of the Study

- To explain the concepts of interdisciplinary and multidisciplinary/integrated education in the 21st

century teaching and learning process.

- To Justify a rationale for introducing multidisciplinary education approaches in the 21st century at all levels
- To identify the barriers in implementing multidisciplinary approaches in 21st century education and suggest strategies to mitigate the obstacles

Methodology

The present study is primarily focused on the textual approach, books, articles, and papers written in various National and International Journals have been considered to do the framework of the study hence the secondary data has been used for the study titled "Multidisciplinary Approaches in the 21st Century Education of Teaching and Learning Process".

Defining Concepts

In modern civilization the advancement of knowledge has taken a path of increasing specialization in different disciplines and the world has been approached to understand by deconstructing it into smaller fragments creating the disciplines and sub-disciplines in order to be able to predict and explain behaviour in nature, individuals, and society. It is important to consider the idea of the discipline itself. Becher (1989) describes disciplines in terms of tribes with recognizable identities and particular cultural attributes and each discipline has its own professional language and literature and defends its territories physical, intellectual, etc. from outsiders. The discipline is different to the subject- a subject

is a knowledge base, whereas a discipline is a tribe, a culture, or a guild (Parker 2002) and each discipline has its history and its heroic myths, through which it is produced and reproduced (Becher 1989). Therefore, the concept of interdisciplinary and multidisciplinary teaching and learning in educational process depends to a large extent upon disciplinarity itself. Effective multi and interdisciplinary teaching and research are not likely to occur without a strong disciplinary base. (Kennedy 2000: 3) and disciplinary studies take place within the bounds of a single, currently recognized academic discipline. Appreciation is due to the artificial nature of subject boundaries and that they are dynamic. Multidisciplinary and interdisciplinary are confused and sometimes are used as synonymous and even more marked when cross-disciplinary and transdisciplinary concepts are introduced. All of them contribute undoubtedly to knowledge generation through different approaches and interdisciplinary approaches can be defined as the conceptual and practical integration of more than one discipline to find solutions to complex a problem that require the participation and interaction of different disciplines and has a common object. Interdisciplinary research refers to the integration of theories and knowledge of disciplines and this can be either multidisciplinary or interdisciplinary. Multidisciplinary approach in teaching and learning process/research in which the researchers work in a parallel way on a certain topic. In this kind of research, specialists from different disciplines are invited to work together as

the topic assigned to each one and different methods and approaches are applied to a common problem/theme and the types of multidisciplinary approaches are additive, integrated, on-disciplinary and synthetic. A multidisciplinary approach brings together several disciplines, usually two/three based on a theme, idea or concept in this approach. While interdisciplinary uses holistic and integral approaches and emergent innovative methods. Multidisciplinary uses of reductionist methods and approaches could be integral and the distinction between multidisciplinary and interdisciplinary can be made in terms of the objectives and the level of interaction in any field of the education system.

Literature Review

In the 21st-century knowledge landscape, there are powerful drivers for multidisciplinary research and multidisciplinary courses equip the educating students with a broad-based educational foundation, one that prepares them to use diverse but compatible educational disciplines to solve the scientific, technical, etc. challenges that increasingly cross “traditional” academic boundaries. Answers/solutions to the existing significant problems faced by the community demand a widespread qualitative improvement in thinking and understanding. Life is multidisciplinary which is a single disciplinary knowledge in education which can’t resolve the diverse contemporary challenges like global warming, climate change, ecological problems, poverty, spreading harmful diseases, overpopulation, distribution of resources,

challenges in planning, administration, public management, etc. without communication and higher problem-solving skills and scientific and technological literacy. (De Zure, 1999) The multidisciplinary learning process in the humanities makes the students gain confidence in promoting new ideas, leading peer groups, managing project teams, and serving as advocates for others and the community students' exposure and deeper understanding of new problems and challenges help them to initiate, organize, and complete collaborative projects in their professional lives also and solving complex problems usually requires collaboration between many professions and integration of different disciplinary skills. (Gibbons et al. 1994). The goal and the aim of introducing multidisciplinary approaches in education is not intended to turn the subjects of any students, into scientists, IT experts, mathematicians, etc. but to ensure a broad understanding of many disciplines and to develop sufficient background knowledge in the fundamental areas such as science, technology, administration, social sciences, etc. Any student with technological skills, scientific knowledge and experience with real-world problems can be easily transformed as a well-trained administrator or planner in his/her community which faces so many challenges and the integration of subjects like social science with maths, science, technology, etc. enable students to think more creatively and identify a technological solution to real-world problems. Facing new challenges, solving

problems and answering complex questions with multiple facets is not possible by using a single-disciplinary approach and it should be answered with a new level of discourse and integrated effective and efficient knowledge in 21st century multiple disciplines.

Collaborative Learning and Teaching Process

Nowadays students are painfully aware of the fact that they can't get job opportunities beyond their academic disciplines. In this competitive scientific-technological world, employers want graduates who can able to meet the multidisciplinary needs of the present world with dynamic changes in knowledge construction, critical thinking and appreciation of diversity. In order to apply more efficient use of human resources in administration more digitized graduates are recruited in every field. In this respect, students have the responsibility for self-motivation and self-learning of science, technology and social sciences in the realm of their everyday life and science and technology should be more humanized and integrated in order to connect it to the areas in which all students are interested. Multidisciplinary approaches in the teaching process can succeed in the courses when only all students collaborate with interest, skills, experience, etc. It will be achieved through interdisciplinary approaches where a unit is taught across different curricular disciplines and subjects can be viewed from different social science perspectives. In English, storytelling can be an important avenue for constructing knowledge in Science, Social Studies and Art and so on. By

implementing multidisciplinary teaching and learning approaches in education, all students who need the depth and focus of disciplinary ways of knowledge for crossing intellectual boundaries realize the importance of the multidisciplinary approach and enjoy its benefits at a large scale and also learn collaboratively as they do group/pair projects and presentations. In fact, everyone benefits as the students see their curriculum addresses the issues in the subjects, across disciplines, in the university as well as in the community. The approach gives not only the students but also the teachers greater flexibility in working together with diverse experiences and knowledge to use multiple approaches and skills for addressing problems and solving them. The multidisciplinary curricular design in 21st-century education seeks to help students learn and appreciate the relevancy of how science and technology are tied together in their everyday life and how these disciplines can be built on to the education and the multidisciplinary approach in the graduate programme enables students to break down the barriers and boundaries about professionals and to face common challenges and issues of community development in order to work in an integrated manner with strong strategic insights. This approach not only recognizes and values the roles of learners and teachers but also the involvement of other stakeholders in the educational process. Teachers today are unleashing the power of communication by introducing learning strategies that rely on social interaction,

dialogue and collaboration in teaching language for instance, one needs to look at aspects of language such as speaking, reading, writing and listening. Students can able to see and connect several subjects and disciplines which enables them to explore the relationship between fields of knowledge in multidisciplinary teaching where collaboration is ideal, teachers from various disciplines come to work together using team planning for instructions and effective teamwork which is the key factor for the success of the approach.

Barriers in Implementing Multidisciplinary Education Approaches

- There are conceptual/ideological barriers which stand in the way of the implementation of this approach at all levels.
- Students became aware of how borders prohibit various individuals from interacting with one another.
- They have problems of working across disciplines, working in different disciplines and synthesizing different disciplines.
- Multidisciplinary teaching and learning approach in education emerges as a disjoint approach.
- There are many difficulties in designing an appropriate curriculum format for multidisciplinary teaching approaches in education.
- Faculty members have to work collectively to create, identify and develop new instructional strategies for the integration of the curriculum.
- Most administrators are against the use of

multiple curricular activities crossing faculty boundaries.

- Separate faculties and faculty structure and bifurcation also disturb the cooperation in teaching and learning.
- Students are provided with multiple disciplinary perspectives but are not given effective guidance in resolving the conflicts and achieving a coherent view of the subject because of the lack of trained lecturers.
- Teachers also still prefer to limit themselves to their traditional subject compartments.
- Lack of well-trained teachers having degrees from two or more disciplines.
- Technology-centered laboratories are also major limitations for implementing multidisciplinary approaches.
- There are difficulties in collaborating with professors and teachers from various disciplines including difficulties in interpersonal communication and lack of commitment in the output of this approach.
- Institutional administrative structure puts barriers in the career path of those who choose multidisciplinary projects/research.
- At the same time students who follow multidisciplinary courses are unable to get scholarships because funding for students is provided by each discipline-funding body.

Strategies towards 21st Century Multidisciplinary Education Teaching and Learning

- Research should be carried out on a large scale

to evaluate the multidisciplinary approach in every field.

- Faculties can introduce joint and combined studies degrees which give students more confidence and enable them to study two or more disciplines.
- There are possibilities to complete a bachelor's degree not only in a discipline but also in a multidisciplinary programme.
- Faculty discussions should seek to create curricular structures that allow deep multidisciplinary at strategic points through the undergraduate years.
- Proposals should, from the start, include the major disciplinary sets like science, engineering, humanities, and social sciences.
- They should be linked to current research efforts at the tertiary level that involve a wide range of approaches, and they should have significant "learning by doing" components.
- Approach multidisciplinary not as a trend, not as a substitute for disciplinary education, but as an essential goal of university education: introducing students to the universe of learning.
- Reward systems in academia have to recognize the different pace with which research may proceed and the fact that it is often a team rather than individual accomplishment.
- Government has to play a vital role in regulating multidisciplinary curricular systems from secondary education and at the same time the national universities at the faculty level must take the responsibility for putting the multidisciplinary

programmes into practice by consulting educationists, researchers and curriculum designers.

- Teacher education should provide exposure to integrated instruction to students as teacher training institutions seem to lack in this area or fail to provide adequate orientation to integrated teaching.
- Professional training of probationary lecturers should also incorporate multidisciplinary methods.
- Collaboration between the schools and academia should be strengthened to provide extension lectures, seminars on research, refresher courses, exhibitions, and current trends/innovations in instructional approaches.
- Training researchers who can transcend the barriers that exist between the disciplines requires innovation in teaching and learning.
- Recognize the benefits for students who gain training in one discipline to be able to acquire training in another and enable it to happen.

Educational Implications and Suggestions

- Schools need to equip themselves with experienced staff who are capable of delivering such an approach and ensure they have the necessary resources.
- There needs to be greater collaboration between different departments and institutions to ensure successful implementation.
- It is essential to focus on improving the quality of instruction and making sure students are engaged with their studies.

- Students should be given the freedom to explore different topics, develop critical thinking skills and gain a deeper understanding of how different subjects interact with each other.
- Provide students with the tools they need to thrive in the modern world.
- It is suggested to start multidisciplinary institutions and academic institutions throughout the country.
- Introduce four year integrated teacher education program in multidisciplinary colleges and universities.
- There is a necessity to popularize the ancient Gurukul system in accordance with the present system of education.
- Students joined with this method will easily cope up with the latest advancement of the global system of education and set competitive mind as a global citizen.
- There is a necessity to establish more and more integrated teacher education centres throughout the country to provide multidisciplinary methods of teaching at every level of education in the country.
- A well-versed and well-maintained curriculum is necessary in teacher education programs to enrich and enhance this new and innovative method of 21st century teaching.

Conclusion

By breaking down the autonomy among the disciplines through multidisciplinary learning, the students are able to realize an improvement in self-esteem, structured learning activities and the

development in teamwork in addressing and solving a problem with input from a large variety of views, while the teachers/lecturers have positive thoughts about the team- teaching environment and the necessity for enhancing their knowledge in different disciplines. This is the urgent need of the present society to bring graduates to cope with the needs of their community and a multidisciplinary approach is a new way in the teaching and learning process which enables to develop of great collaborative working and understanding. The establishment of a new level of discourse and integration of knowledge in academic studies through a multidisciplinary approach is the outcome of the introduction of this approach in education. But there are some barriers in the way of implementing this approach and though few strategies have been suggested to overcome the long-standing conceptual, methodological, administrative and institutional barriers in implementing multidisciplinary teaching and learning approaches in 21st-century education, it won't be achieved successfully within a short span of time. Because all of these barriers reflect not only the general psychological tendencies and socio-political dynamics but are also shaped by various historical, cultural and institutional conditions case studies and research should be carried out at the tertiary level. Further investigations in interdisciplinary and multidisciplinary teaching and learning are necessary and more needs to be known about how colleagues teach in multi and interdisciplinary ways

in the classroom and how lecturers interact with the intellectuals outside their disciplines teaching on the same course. Hence we can say that multidisciplinary approaches in education at the tertiary level are vital in the present global trend It is believed that the global world is a socially, economically, politically, culturally, linguistically, etc. diverse entity that can best be comprehended only through a multidisciplinary perspective. As an innovation, it tries to rectify the divisive effects that the old traditional concept of learning as a discipline, pursued in the study of subjects, has upon the child's concept of knowledge and multidisciplinary instruction enables learners to recognize contrasting perspectives, synthesize, think critically, and re-examine the world. Therefore, multidisciplinary approaches in the education at the tertiary level should be explored encouraged, and utilized in appropriate ways considering various parameters.

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ENHANCING LIFE SCIENCE EDUCATION: A REVIEW OF SKILL DEVELOPMENT THROUGH EXPERIENTIAL LEARNING

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ABSTRACT

The life sciences are a constantly changing topic, thus teaching methods must provide students with practical skills and the ability to solve problems in the actual world in addition to academic knowledge. With its ability to provide students with immersive, practical experiences that improve their professional and cognitive abilities, experiential learning has become an essential part of the life sciences curriculum. This paper emphasizes how well it fosters the technical, analytical, and interpersonal skills necessary for success in the classroom and in the workplace. The increased need for Experiential learning is also addressed by incorporating experiential learning into the curriculum of the life sciences.

Keywords: experiential learning, skill development, life science education, statistical significance, assessment tools.

Introduction

Life science education is changing quickly because it must give students the fundamental information and real-world skills they need to tackle today's complex global issues. Traditional lecture-based education is no longer adequate to prepare students for the demands of professions in biology, biotechnology, environmental science, healthcare, and related sectors as scientific investigation becomes more interdisciplinary and practical. Experiential learning is becoming increasingly important in life sciences courses as a way for educators to bridge the gap between theoretical knowledge and practical application. A potent method for developing skills in the life sciences is experimental learning, which entails active engagement in practical tasks, real-world problem-

solving, and reflective practices. In contrast to traditional teaching approaches that prioritize the dissemination of knowledge, experiential learning involves students in the process of experimenting, testing, and critical thinking. This pedagogical approach cultivates deep learning, and essential technical and analytical skills, and prepares students for future challenges in scientific fields by giving them opportunities to apply theoretical concepts in a variety of settings, such as laboratories, natural environments, research projects, or professional work placements.

This paper examines the function of experiential learning in the teaching of life sciences, emphasizing how it improves the development of skills in various circumstances. The paper attempts to highlight excellent practices and offer insights

into the integration of experiential learning into life sciences courses. The study specifically addresses the ways in which a variety of experiential learning strategies including lab work, usage of various experiential tools, and hands-on experiments help students develop a broad range of skills.

Ultimately, this analysis emphasizes how important it is for life sciences education to give experiential learning a top priority. Teachers need to equip pupils to not only comprehend theoretical concepts but also apply them creatively in the face of expanding scientific knowledge and increasingly complicated global concerns. Life sciences programs can better prepare students for success in academic and professional environments by incorporating experiential learning. This will help to produce a new generation of scientists who can significantly impact society.

Life Science Education

A foundational knowledge of life science is required to solve global issues including public health, biodiversity loss, and climate change, as well as to comprehend the biological processes that form live organisms and ecosystems. Beyond typical classroom training, education must be expanded to properly prepare students for vocations in biology, healthcare, environmental science, and biotechnology. Combining practical experiences with academic information to foster deeper comprehension and skill development is one effective way to accomplish this goal in life science education through the use of experiential learning. Interaction between practical learning and life

science education helps foster the growth of multidisciplinary abilities. Professionals in today's complicated scientific environment need to be skilled in problem-solving, collaboration, and effective communication in addition to technical procedures. Students who participate in experiential learning have the chance to practice teamwork, reflection, and approach adaptation all of which are critical abilities in academic and professional contexts.

Skill Development

Education must prioritize the development of students' skills, particularly in areas like the biological sciences where practical knowledge and hands-on experience are essential. Education systems must place equal emphasis on developing practical, transferable skills and theoretical knowledge development in response to changing workforce demands. One of the most effective ways to do this is through experiential learning, which gives students the chance to apply concepts, interact with real-world situations, and build a broad range of skills. Teachers may design immersive, dynamic learning environments that help students succeed academically and get ready for the workforce by fusing experiential learning with skill development.

Experiential Learning

A method of teaching called experiential learning places more emphasis on learning through practical, hands-on experience than it does on knowledge acquisition. Drawing from the scholarship of educational theorists such as David

Kolb, it is a cyclical process in which students participate in tangible experiences, contemplate those experiences, formulate their findings, and apply their newly gained knowledge to other contexts. Through active participation in simulated or real-world events, this approach facilitates deeper knowledge by enabling students to make the connection between theoretical concepts and real-world applications. The cyclical process of experiencing, thinking, experimenting, and reflecting improves knowledge retention and comprehension. Experiential learning fills the knowledge gap between academic theory and practical application by immersing students in real-life circumstances or practical activities. This helps students become ready for the complexity of real-world challenges. Encouraging them to absorb lessons from both their achievements and failures, helps them develop a stronger, more intimate bond with the material.

Key Components of Experiential Learning

Active Engagement: Students take part in exercises that imitate situations or issues from the actual world. This could include field research, simulations, lab work, and internships.

Following an activity, students consider what they have learned and what the guiding ideas are by reflecting on their experiences. Students who reflect on their work are better able to make connections between theory and practice.

Conceptualization: Drawing on their experiences and reflections, students formulate theories or

concepts. This stage entails information analysis and synthesis to create a more comprehensive knowledge.

Application: Students verify their comprehension and modify their approaches as necessary when they apply the recently acquired principles to various scenarios or issues.

Objectives of the Study

Assess the Impact of Experiential Learning on Skill Development: To assess the ways in which various types of experiential learning including lab work, research projects, and experiential tools—help students in the life sciences field build their technical and soft skills.

Identify Effective Experiential Learning Strategies: Determine the best practices and methods for incorporating experiential learning into the life sciences curriculum and examine how they improve student engagement and learning results.

Examine Student Outcomes and Competencies: To find out how experiential learning affects critical thinking, problem-solving, communication, and teamwork among other student competencies, and to ascertain the ways in which these competencies support academic and professional preparedness.

Examine Challenges and Solutions: This section will examine the difficulties in integrating experiential learning into the life sciences curriculum, including issues with resource allocation, curricular integration, and assessment techniques. It will also make suggestions for possible solutions.

Enhance Educational Practices: To give educators

and organizations advice on how to successfully integrate experiential learning into life sciences curricula in order to enhance instruction and better position students for success in the workplace.

Experiential Learning Tools and Equipment in Life Sciences

Biotechnology kits

Contains supplies for cloning, gel electrophoresis, PCR (Polymerase Chain Reaction), and DNA extraction. With the help of these kits, students can learn about molecular biology principles and conduct genetic analyses.

Microscopy Kits

These contain prepared slides and microscopes for the study of tissues, cells, and microbes. Students can learn about histology and cellular biology with the aid of these kits.

Chemistry Kits

hold supplies and tools needed to conduct titrations, synthesis tests, and chemical processes. The fundamentals of chemistry and biochemistry are taught using these kits.

Methodology

This section describes the methodology used to assess how well experiential learning improves education in the life sciences. The emphasis is on useful resources such as microscopy, chemistry, and biotechnology kits that were incorporated into the curriculum to facilitate practical learning and hands-on experiments.

Research design

The study uses a pre-test/post-test control group strategy in a quasi-experimental design. This

arrangement makes it possible to compare experiential learning using specialized kits side by side with standard textbook-based training. Finding out if using these useful tools considerably enhances student performance and engagement in the life sciences is the goal. This is done in two ways of testing

General testing involves tests conducted on all the students in a class to measure their academic performance before and after the intervention of experiential learning tools.

Hypothesis testing refers to the comparison of the learning outcomes of two groups of students – a control group (Traditional textbook strategy) and an experiment group (experiential tools).

Intervention of Experiential Learning with Tools

The experimental group participated in a number of hands-on activities using the biotechnology, microscopy, and chemistry kits over the course of the 8-week intervention.

Biotechnology Kits

These kits contained supplies for investigations including bacterial transformation, gel electrophoresis, and DNA extraction. These kits gave pupils the ability to see and control biological processes, which helped to bring abstract ideas to life.

Example Activity

Using the biotechnology kits, students were able to examine and handle genetic material by extracting DNA from plant cells. This practical exercise strengthened their grasp of genetics and molecular

biology.

Microscopy Kits: Using the microscopy kits, pupils were able to view tissues, bacteria, and cell structures up close. With the use of these kits, students were able to learn more about the invisible side of biology and improve their comprehension of microbiology and cell biology.

Example Activity: Students created slides of onion cells and used microscopes to identify and comprehend the activities of distinct cell organelles. This exercise aided in the study of biology's structure-function relationship and cell theory.

Chemistry Sets: Materials for performing experiments on chemical reactions, pH levels, and molecular bonding were provided in the chemistry kits. The chemical concepts that underlie biological processes were illustrated using these kits.

Example Activity: Students investigated how acidity and alkalinity affect enzyme activity by conducting pH experiments using the chemical kits. This helped them understand the chemical foundations of metabolic processes in living organisms.

Assessment tools

Both the development of practical skills and the acquisition of information were measured using standardized testing measures in order to examine the efficacy of the experiential learning strategy.

Pre-Test

Prior to the intervention, this test evaluated the participants foundational understanding of the subjects covered in the kits relating to the life

sciences.

The examination comprised

Multiple-choice questions: Centred on important ideas including cell structure, molecular biology, and chemical processes in biological systems.

Short answers: Students were asked to explain procedures such as cell division, DNA replication, and enzyme action in short answer questions.

Practical skill Assessments: Include things like detecting cell structures under a microscope, carrying out simple chemical experiments, and deciphering the findings of research involving biotechnology.

Post-Test

The post-test, administered after the 8-week intervention, was identical in structure to the pre-test. It aimed to measure the extent of knowledge retention and the ability to apply skills in practical settings.

Test Validity and Reliability

The assessments were designed to be valid and reliable measures of student learning outcomes. They were pilot-tested and refined to ensure consistency and accuracy in evaluating the impact of the experiential learning tools.

Data Collection

Data were gathered twice: once during the pre-test and once following the intervention(post-test).

Pre-Test Data Collection: To create a baseline for comparison, the pre-test was given during the first week of the study. To ensure that any variations seen in the post-test could be linked to the intervention, the same testing procedures were used

both before and after the intervention.

Post-Test Data Collection

The post-test was given out right away following the eight-week intervention. To guarantee comparability, the circumstances were maintained at the same level as the pre-test.

Data Recording: A database was used to safely store student test results. To examine changes in knowledge and skills, each student's performance was monitored.

Consistency measures: These include maintaining the same test conditions and instructions to make sure the data accurately reflects the impact of the experiential learning tools.

Data Analysis

The purpose of this data analysis was to compare the results among the students to ascertain whether the experiential learning tools were beneficial in raising student performance.

General Testing Analysis

The general testing analysis seeks to evaluate the effect of experiential learning on student performance by comparing test results obtained before and after the intervention (pre-test and post-test). This investigation sheds light on how well students' comprehension and proficiency in the life sciences are improved by experiential learning resources like microscopy, chemistry, and biotechnology kits.

Descriptive Statistics

The data gathered from the general testing phase is summarized by the descriptive statistics table below. These numbers are essential for

comprehending the variability and central tendencies in student performance both before and after the experiential learning intervention.

Table 1. Descriptive Statistics for Pre-Test and Post-Test Scores in the Experimental Group

Experiential Learning Tools	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	Mean Improvement
Biotechnology Kits	68.5	7.4	82.3	6.2	13.8
Microscopy Kits	70.1	6.8	85.7	5.9	15.6
Chemistry Kits	67.9	7.1	80.9	6.5	13.0

Interpretation from Table 1

Pre-Test Mean- Prior to the intervention, the pre-test mean scores represent the starting point of knowledge and proficiency. The biotechnology kits, for instance, have a mean score of 68.5, indicating a moderate degree of understanding before the experiential learning activities.

Post-Test Mean- Following the intervention, the knowledge and abilities obtained are reflected in the post-test mean scores. The increased post-test means (biotechnology kits, for example, 82.3) indicate a significant improvement in students' knowledge.

Standard Deviation

The SD for the students' performance on the pre- and post-tests gives information about how consistently they performed. A drop in SD from the pre-test to the post-test (for biotechnology kits, for example, from 7.4 to 6.2) can suggest that the intervention was successful in bringing the group's learning outcomes closer to par.

Mean Improvement

The difference between the means of the pre- and

post-tests is known as the mean improvement. The effectiveness of the experiential learning methods in improving students' performance is indicated by a positive mean improvement.

Paired t-test

A statistical technique used to assess if there is a statistically significant difference between the mean scores before and after the intervention is the paired t-test. When comparing two related groups, such as the pre- and post-test results of the same students, this test is appropriate. The purpose of this paired t-test is to determine whether the student performance gains that have been seen are statistically significant, meaning that the increases are probably the result of the intervention rather than chance.

Table 2. Paired t-Test Results for Pre-Test and Post-Test Scores in the Experimental Group

Experiential Learning Tools	Mean Difference	SD of Differences (SSD)	t-value	p-value
Biotechnology Kits	13.8	5.1	9.1	< 0.001
Microscopy Kits	15.6	4.9	10.2	< 0.001
Chemistry Kits	13.0	5.4	8.4	< 0.001

Interpretation of Table 2

Mean Difference (D)

Positive mean differences show that students did better on the post-test than the pre-test (for example, 13.8 for biotechnology kits).

t-Value

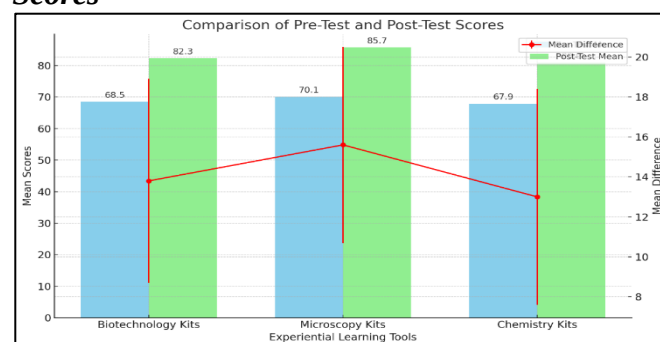
The mean difference and the standard deviation of differences are used to compute the t-values, which are, for example, 9.1 for biotechnology kits. The difference is more substantial the higher the t-value.

p-Value

All activities had p-values less than 0.001, which

suggests that the score improvements are very significant. This shows that students' performance was significantly improved by the use of instruments for experiential learning.

Figure 1. Comparison of Pre-Test and Post-Test Scores



The comparison of pre-and post-test results for various experiential learning aids is shown graphically above.

Hypothesis Testing Analysis

In the hypothesis testing stage, two groups of students are taken into consideration, after teaching the concepts in two different ways by dividing the students one group learnt by using the Traditional textbook way and the other group learnt by using the Experiential way, their post-test results are compared between the experimental group (who used experiential learning tools) and the control group (who used traditional textbook-based approaches). Whether experiential learning produces noticeably better results than conventional techniques is determined by this analysis.

Participants

The study comprised 60 school students who were enrolled in a life sciences course. Either the experimental group or the control group was

randomly assigned to them.

Selection Criteria: The willingness of the students to engage in the study and their enrolment in the course were the main factors in their selection. The comparison of the two groups' previous knowledge, academic aptitude, and demographic traits was carefully checked.

The control group (n=30): they were given standard teaching without the use of specialized kits. This included lectures, reading assignments, and written exercises. In order to assess the effectiveness of the experiential learning techniques, this group acts as a control.

The experimental group (n = 30): Received opportunities for hands-on learning through the use of the chemistry, microscopy, and biotechnology kits. These students took part in tasks that asked them to put their theoretical understanding into real-world situations.

Demographics: To guarantee that the results were widely relevant, the study included students from a variety of backgrounds.

Table 3. Demographic Characteristics of Participants by Grade Level and Age Group

Demographic Characteristic	Category	Experiential Group (N=30)	Control Group (N=30)	Total (N=60)	Percentage (%)
Gender	Male	14	15	29	48.3%
	Female	16	15	31	51.7%
Age Group	15-16 years	18	17	35	58.3%
	17-18 years	12	13	25	41.7%
Grade Level	Grade 10	18	17	35	58.3%
	Grade 12	12	13	25	41.7%
Previous Exposure to Experiential Learning	Yes	5	4	9	15.0%
	No	25	26	51	85.0%

Formulation of Hypotheses

This study investigates the impact of experiential learning on student performance in life sciences.

Specifically, it aims to test the following hypotheses:

H₀: There is no significant difference in student performance between the control group (traditional textbook method) and the experimental group (experiential learning).

H₁: The experimental group (experiential learning) performs significantly better than the control group (traditional textbook method).

Descriptive statistics: A common assessment is conducted after a period of time for both the control and experimental group students and the data collected from the test results are mentioned in the table below.

Table 4. Descriptive Statistics for Control and Experimental Groups

Group	Mean (M)	Standard Deviation (SD)	Minimum Score	Maximum Score	Range
Control Group	72.4	7.2	60	85	25
Experimental Group	83.9	6.3	70	95	25

Interpretation from Table 4

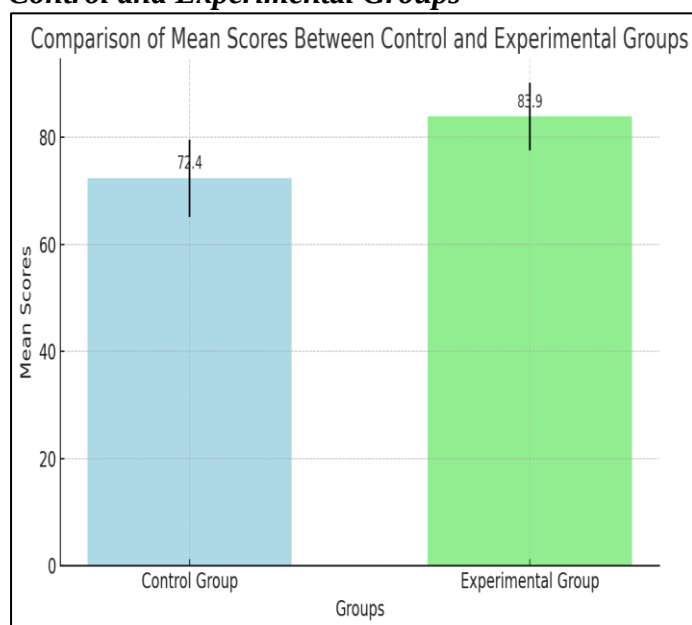
Mean Comparison: The experimental group's mean score (83.9) is noticeably higher than the control group's (72.4). This implies that, on average, pupils who participated in experiential learning outperformed those who adhered to standard textbook approaches.

Standard Deviation Comparison: Compared to the control group (7.2), the experimental group's standard deviation (6.3) is marginally lower. This suggests that students who used experiential learning materials performed more consistently because the results in the experimental group are

more closely clustered around the mean.

Range Comparison: The same range of values (25) applies to both groups, suggesting a comparable distribution of scores from the lowest to the greatest. Nonetheless, it appears that the experimental group performed better overall because they had higher maximum and minimum scores (95 vs. 85 and 70 vs. 60, respectively).

Figure 2. Comparison of Mean Scores Between Control and Experimental Groups



This bar graph shows the average scores for the experimental group (experiential learning) and the control group (conventional textbook technique). In order to illustrate the standard deviations and provide insight into the diversity within each group.

Findings of the Study

The study's results are shown in this section, with particular attention paid to how students performed both before and after the experiential learning intervention and between the experimental (experiential learning) and control groups

(conventional textbook technique). The above-performed statistical research demonstrates that practical learning improves students' performance in the life sciences. The experimental group's post-intervention ratings showed a significant improvement, indicating that interactive, hands-on learning activities have a favourable effect on student outcomes.

Furthermore, the idea that experiential learning is more successful than conventional textbook approaches is further supported by the comparison between the control and experimental groups. Together with the independent t-test's statistical significance, the experimental group's higher mean score suggests that experiential learning may improve students' academic performance as well as their level of motivation and engagement.

Discussion

Interpretation of Results

Effectiveness of Experiential Learning

In comparison to conventional textbook-based methods, the study's findings show that experiential learning greatly improves student performance in the biological sciences. Following the intervention, the mean scores of the experimental group, who participated in hands-on activities utilizing microscopy, chemistry, and biotechnology kits, significantly improved. This improvement was both practically and statistically significant, indicating that experience learning is a more effective way to teach Life science.

Implications for Educational Practice

This study's conclusions have significant

ramifications for educators, curriculum designers, and legislators.

Curriculum design: The life sciences curriculum can benefit from including experiential learning to help close the knowledge gap between theory and practice. This method not only improves comprehension but also gives students the skills such as critical thinking, problem-solving, and teamwork that employers in the contemporary workforce are beginning to value more and more.

Professional Development and Teacher Training: Teachers may need further training in student-centred learning environments and the use of practical educational resources in order to properly apply experiential learning. Therefore, the main goal of professional development programs should be to provide teachers with the knowledge, tools, and abilities they need to successfully incorporate experiential learning.

Limitations of the Study

Although the study's findings are encouraging, it is important to recognize a number of limitations, including:

Sample Size and Generalizability: The research was done using a limited sample size, which can have an impact on how broadly the results can be applied. In order to validate the findings and guarantee their applicability to a wider variety of educational contexts, future investigations should try to duplicate this study with larger, more varied populations.

Short-Term vs. Long-Term Effects: A short time following the intervention, student performance

was assessed in this study. It's uncertain if experience learning continues to provide advantages over time. To evaluate this educational approach's long-term effects on students' learning and knowledge retention, longitudinal studies are required.

Potential Biases: The comparison of pre-and post-intervention scores in the study design may have introduced biases like the Hawthorne effect, in which subjects behave differently just because they are aware that they are being watched. Furthermore, selection bias may be introduced if the experimental and control groups are not assigned at random.

Recommendations

Building on the findings and limitations of this study, several avenues for future research are suggested:

Longitudinal Studies: Future studies ought to look into how experiential learning affects students' performance and involvement over the long run. Research of a longer duration may shed light on the ways in which various instructional strategies affect students' academic paths and STEM-related career decisions.

Comparative Studies Across Different Disciplines: Although the biological sciences were the focus of this study, it would be helpful to investigate the effects of experiential learning in other STEM fields, such as physics, chemistry, and engineering. Comparative research could be used to determine the advantages and difficulties of experiential learning that are unique to a given

discipline.

Impact on Various Student Demographics:

More investigation is required to determine the effects of experiential learning on a range of student demographics, including those with varying degrees of prior knowledge, socioeconomic backgrounds, and learning requirements. Knowing these dynamics could help develop more individualized and inclusive teaching strategies.

Conclusion

This paper has clarified how important experiential learning is to the advancement of life science education, especially when using microscopy, chemical kits, and biotechnology kits. The analysis demonstrates that practical experiences have a substantial positive impact on skill development and give students a more profound and useful understanding of the biological sciences.

The analysis of test data shows that students who used these experiential learning resources had significant increases in mean scores and decreases in standard deviation. Specifically, as indicated by higher mean scores and more consistent performance across exams, students using biotechnology kits showed significant improvements in their comprehension of genetic and molecular procedures. Likewise, microscope and chemistry kits enabled a deeper understanding of microscopic structures and chemical processes, respectively, improving mean scores and lowering variability in students' learning outcomes

To conclude, the review's findings firmly suggest that these Experiential learning tools should be

used in life science education. Experiential learning strategies have been shown to be beneficial in promoting a deeper and more consistent grasp of life sciences, as seen by the reported gains in test mean and standard deviation. As educational practices evolve, leveraging these tools will be essential in preparing students for successful careers in the rapidly advancing field of life sciences.

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FOOD CHOICES OF CHILDREN

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ABSTRACT

The empirical study aims to find among school children whether they make smart food choices. The study was carried out in the schools of Tirunelveli and Palayamkottai in the mid of 2018. The design of the study was descriptive in nature and a survey technique was used to collect data. The population consisted of adolescents studying in schools and a sample of 460 students was drawn from 11 schools using a simple random sampling technique. The food Choice checklist developed and validated by S. Francisca and L. Arul Suganthi Agnes in 2018 was used to collect data. The collected data was quantified and analysed using mean, SD, 't' test and ANOVA. Results revealed that the male and female children significantly differ in their food choices. There existed no significant difference in their food choice among high school children with regard to their locale.

Keywords: children, food choice, obesity, fast food

Introduction

Education or learning in the broadest sense is any act or experience that has a formative effect on the mind, character or physical ability of an individual. In its technical sense education is the process by which society deliberately transmits its accumulated knowledge, skills and values from one generation to another. Education is the significant factor which determines a country's socioeconomic and cultural development. Education is important for any country's betterment. According to Spencer, "Education is complete living." The aim of education is to help the development and expansion of the pupil's physical, mental, intellectual, moral and aesthetic powers in a balanced way. By education says Mahatma Gandhi, "I mean an all-round drawing out of the best in child and man-body, mind and spirit". Education is

the creation of a sound mind in a sound body." It is clear from the above definitions that only a sound and healthy body can serve as a base for education.

Significance of the Study

Food is the basic requirement of every human being for the very existence of life. It is required for building the body, provides energy and regulates the activities of the body. It decides the health of an individual and therefore that of the nation. While pure wholesome food promotes and preserves health, fast food or junk food affects the health of an individual. Food is one of the delights of every civilization. Preparation of some dishes in many cultures is an art. Eating a fine meal is an aesthetic experience, not just fulfilment of nutritional requirements, but even the simplest dish can provide great pleasure. Teachers can use this positive approach in presenting nutrition concepts.

Hurried meals in haphazard settings may be deleterious because of the type and amount of food as well as how the food is eaten. The number of overweight children is increasing. Obesity is a problem influenced by the individual's physical, social and emotional environment. Improper food habits, overeating and improper snacking are also reasons for obesity.

In our fast-paced society, people opt to skip meals or to eat a poorly balanced meal at a fast food restaurant. Many parents and teachers fail to provide good examples for their children concerning nutritional habits. The need for nutrition education is crucial. In our older days, our elders had healthier food habits. But today our food habits have changed a lot. We give importance to taste and not health. The younger generation of today has a craze for such food rather than traditional food. So, it is important to investigate the factors influencing the change in food habits in growing children and to create awareness among them about the evil effects of fast food. As the most important phase of growth takes place during the adolescence stage, this study was conducted among high school students. The well-nourished child is more apt to reach his/ her full potential physically, mentally and intellectually. We can expect any percentage of intellectual growth only when the child is physically fit. The results of the study may be helpful for parents to guide their wards into healthy food choices. The results of the study may encourage the teachers to educate their students to have better food habits. Most importantly the results may compel the administrators to include

nutrition education as one of the aspects of curriculum.

Statement of the Problem

- Food Choice of the children influences them food habits.
- If the food choice is better, they lead a healthy life.
- Are they smart in making their food choice?

Objective of the Study

To find the significant difference if any between high school students in food choice with reference to gender, class, locality and type of school.

Methodology

The investigators adopted a descriptive method using the survey as a technique to collect data. The population for the present study was the high school students of Tirunelveli. Four hundred and sixty high school students were drawn using a simple random sampling technique. The food choice checklist was developed and validated by S. Francisca and L. Arul Suganthi Agnes in 2018. To analyse the data the investigators used mean, SD, 't' test and ANOVA.

Analysis of Data

Table 1. Difference between High School Students in their Food Choice with regard to Gender

Variable	Category	Count	Mean	SD	't' value	Result
Gender	Male	220	51.09	10.49	2.34	Significant
	Female	240	48.93	9.24		

(At 5% level of significance the value of 't' is 1.96)

It is very clear from the above table that the calculated 't' value is greater than the table value. Comparing the mean scores significant difference

as found between male and female in their food choice. Male students' food choices seem to be better than the female students.

Table 2. Difference between High School Students in their Food Choice with regard to Class

Variable	Category	Count	Mean	SD	't' value	Result
Class	IX	252	48.58	9.41	3.31	Significant
	X	208	51.64	10.25		

(At 5% level of significance the value of 't' is 1.96)

It is very clear from the above table that the calculated 't' value is greater than the table value. Comparing the mean scores significant difference was found between IX and X standard students in their food choice. X class students' food choice is seems to be better than the students of IX standard.

Table 3. Difference between High School Students in their Food Choice with regard to Locality

Variable	Category	Count	Mean	SD	't' value	Result
Location of school	Rural	214	50.91	9.57	1.93	Not significant
	Urban	246	49.14	10.13		

(At 5% level of significance the value of 't' is 1.96)

There is no significant difference between high school students in their food choice irrespective of the locality they belong to.

Table 4. Difference among High School Students in their Food Choice with regard to Type of School

Variable	Category	Count	Mean	Sum of Squares	df	F	Result
Type of school	Govt.	123	50.36	3324.51	2	18.21	Significant
	Aided	140	53.53	41719.79	458		
	Matric.	197	47.18	45044.30	460		

(At 5% level of significance the value of F ratio is 3.09)

There is significant difference among high school students in their food choice with regard to type of

school

Findings and Interpretations

Male and female students significantly differ in their food choices. The food choice of male students is found to be more desirable than the female student's food choice. The reason may be that, male students have more desirable food choices and they attend nutritional awareness program. They go out to restaurants and snack bars. So they develop more liking for balanced food culture. Moreover, male children are parent's pets and they are more adorable than girl children. So the parents fulfill their desires and wishes. And we can also say that boy's taste buds are more sensitive. This result contradicts the previous study by Caine-Bish, Natalie L; Scheule, Barbara (2009) where the results showed that boys preferred meat, fish and poultry foods over girls; girls preferred fruits and vegetables over boys.

Students of IX and X significantly differ in their food choices. The food choice of X-class students is found to be more desirable than their juniors. This may be due to the maturity they gained and the responsibility and care for their health considering their examination. The study reveals that there is no significant difference between rural and urban students in their food choices. Children from rural and urban have more awareness towards fast food items and even they order from anywhere. The reason may be that there are many fast food openings and the children are exposed to such foods.

There is significant difference among high school students in their food choice with regard to type of

school. The aided school students have more desirable food choices than their counterparts. Comparing the students of three types of schools the students of matriculation schools have more undesirable food choices. The reason may be that, though the students may have an awareness towards fast food, they prefer fast food because fast food is more appealing to their taste buds. There may be other reasons also like peer pressure, fashion, social culture, parental influence etc. These findings are strengthened by the previous study of Karen Brown, Heather McIlveen, and Christopher Strugnell (2000) suggests that the food preferences of adolescents are often with “fast food” style and consequently the food habits of many young consumers may fuel the consumption of poor nutritionally balanced meals. While young consumers were aware of healthy eating, their food preference behaviour did not always appear to reflect such knowledge, particularly within the school and social environments.

Educational Implications

The investigators recommend the following for improvement.

- Professionals like dieticians and Pediatricians should design effective strategies to improve adolescents’ diets.
- Family members and teachers can influence the food preferences of adolescents by providing healthy food choices, offering multiple opportunities to prepare and eat new foods, and serving as positive role models through their own food choices.
- A research-based nutrition education may serve

the purpose.

- The nutritional awareness programme should influence the students not only at the cognitive level but also at the affective level, so that they may apply it in life by making healthier food choices.
- Nutrition education should start at the nursery school level itself. Do’s and don’ts of eating should be taught at schools.
- Nutrition education should be made as a compulsory subject, taught by trained professionals.

Conclusion

The present study clearly indicates the impact produced by the growing fast food culture on adolescents and their addiction to such foods. Our children are becoming the victims of the taste of this unhealthy food style which affects their physical health. Moreover, high school students are crossing an important phase of the educational process which decides their future careers. So their physical health should be taken sufficient care of to make them intellectually challenging individuals. So, it is the duty of parents and teachers to impart fast food awareness and help them choose healthy food items. Nutrition education becomes crucial at every stage of school education.

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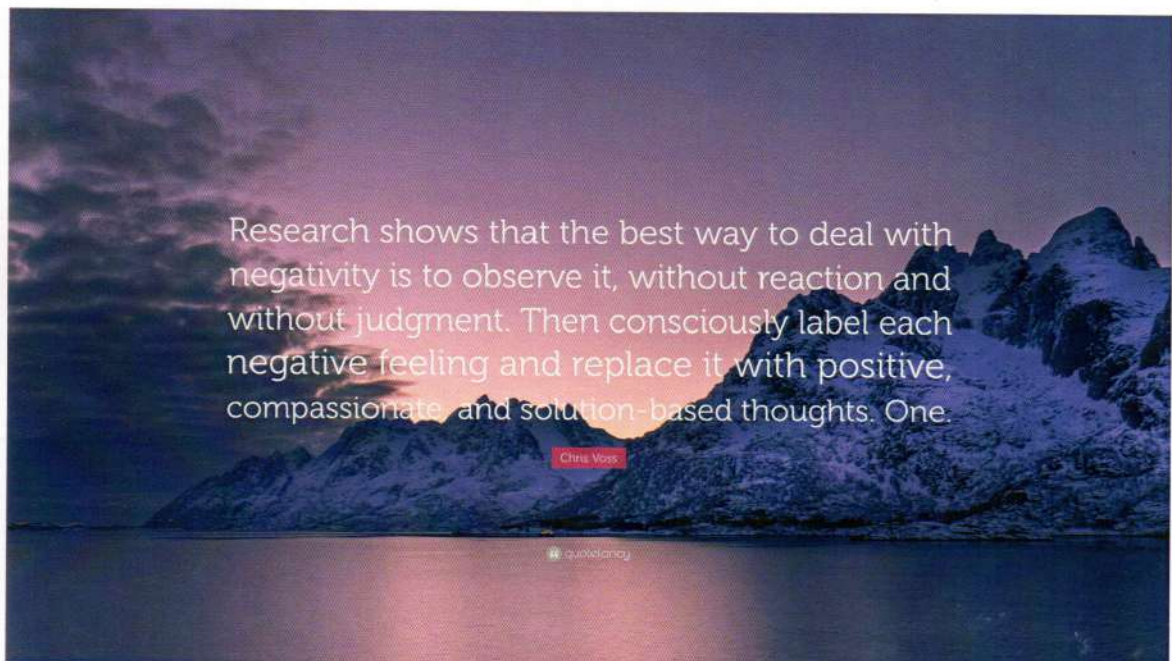
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