4.1 Research Problem:

National curriculum framework 2005 identified the problem in our educational system and suggested reforms and guiding principles to transform our educational system. The new system should be child-centered and enable children to learn without burden and learn with understanding – deeply and meaningfully, which helps them realize their potential.

Imaginative use of ICT should help us extend educational opportunities to all and enhance quality of education at all levels. We need strategy to integrate the efforts of schools, Government and industry to create and share an environment that helps every student to achieve his/her full potential and prepare them for the knowledge age.

Schools need to develop strategies for effective dissemination of knowledge with the vision of life long learning. The management of schools needs to take a strategic approach in developing vision, systems, processes, networks and e-learning materials to empower teachers and create a learning environment in which children enjoy and learn how to learn. The strategy should be simple, flexible and responsive to learner's needs. The strategy...
should integrate and unify the e-Learning initiatives by Government, Industry, educationists and schools. The aim is to create and share an environment in which children enjoy learning, learn together and learn how to learn with equal opportunities for all of them — with no child left behind.

4.2 Research Objectives:

- Indicate how sharing of a simple, motivating, interactive and learner centric environment helps students to collaborate, learn how to learn and enjoy learning while being actively involved in the learning process.
- Indicate how the key elements of an e-learning strategy namely teacher, content, access, technology and collaboration impact the quality of learning and the access to it.
- Identify the strategic actions required to meet the objective of learning opportunities for all and move towards an education system that helps students learn with smile and learn how to learn to keep smiling throughout their lives.
- Establish the key benefits of the proposed SMILE strategy.

4.3 Scope of proposed strategy:

The strategy should help to balance e-learning with traditional methods, recognising their value and using e-learning only where appropriate to suit individual learning and teaching styles. This will be an evolving and responsive strategy for continuous improvement in the learning environment and learning outcomes. At the heart of the strategy will be the aim to
create conditions in which students enjoy learning, learn to share and learn how to learn. Scope of our strategy to be sufficiently focused is limited to the use of technology in creating a learning environment in schools to enhance learning experience and learning opportunities for all. The strategy shall ensure creating a learning environment for secondary education with full range of pedagogic opportunities provided by ICT. This research paper explores and suggests a strategic framework to create conditions in school environment, which enhance the learning experiences, promotes learning with understanding and prepares students to face the future with confidence. Because of the broad nature of topic, the paper focuses on issues related to creating a motivating learning environment in schools for secondary education covering eighth to tenth grades by leveraging ICT.

The strategy is guided by the vision that every child should enjoy learning and achieve his/her full potential. This vision sets the objectives for the strategy, which empower both students and teachers and extend the reach of quality education to every student. Enjoy learning, learning how to learn, active learning, collaborative learning, learning opportunities for all are the strategic objectives, which guide the strategy. The focus of strategy proposed in this research work is on key elements namely content design and delivery, technology, access and collaboration and strategic actions required to achieve the benefits that lead to realizing strategic objectives, omitting reference to strategy implementation aspects such as resources, leadership, communication, funding, policies, systems and processes, educational management benefits of ICT and the associated costs. Benefits of the strategic actions proposed in this research work include learning flexibility, learning to share and sharing to learn, new ways of learning, which empower students and innovation in teaching and learning.
The research study is limited to schools offering secondary education but the results of the study can also be extended to evolve strategies for primary education, higher secondary education and higher education with appropriate changes. The strategic actions have been suggested with the assumption that teachers drive the strategic vision and would be adequately empowered with the required resources and training.

4.4 Literature review:

The literature review was important to study the existing and ongoing studies on learning, e-Learning, strategies in the new economy and e-Learning strategies, for ex: Detailed study on the learning theories, models and concepts, Strategies in the new economy and Strategy for creating a value in the networked world, Strategies for e-Education and a unified e-Learning strategy. The literature review reveals that e-learning initiatives in the national and international context are aimed at identifying and establishing good practices with regard to schools for knowledge sharing, shared resources, online communities, open access to e-Learning content, widening access to quality educational resources and professional development of teachers.

Literature review has been carried out to study the importance and relevance of learning theories and models in creating an ideal learning environment that can meet our strategic objectives by leveraging technology. Learning theories have been analysed by studying their impact on learning environment and the ideas from different learning theories have been synthesized to arrive at the essential requirements of a learning environment from the perspective of content design and delivery covering curriculum, instruction design and assessment. SMILE (simple, motivating interactive, learner centric environment) integrates
the key ideas from learning theories and offers a more holistic approach to learning, which is child centered. SMILE can be shared through a collaborative-networked learning environment to meet our strategic objectives.

Literature review on strategy suggests that the proposed strategy should be simple, scalable and flexible so as to leverage the value created in a networked world through principles of arbitrage, aggregation, rewiring and assembly. The value can be created at the ends through orchestration of modular intelligence in the form of reusable learning objects by leveraging common networked infrastructure and educational resources. Strategy should be simple and guided by simple rules around key strategic processes such as content design and delivery, assessment and feedback, access to content and collaboration for sharing knowledge. All the strategic processes so identified should be guided by learner centric approach and teacher shall drive the strategy as a facilitator, coach and guide.

4.5 Bench marking Study:

Successful e-learning initiatives in Europe, USA, Canada, Australia and India and educational portals for school students such as BBC, Discovery school, Euro school net and Wonder whiz kids have been studied for identifying the best practices. The key elements of strategy have been identified through the study of successful e-learning initiatives in developed countries such as U.K and Australia. They have been identified as content, access, technology and collaboration. Strategic actions required to realize the strategic vision has also been identified by studying the best practices and research findings of various initiatives by Governments of U.K, Australia, Canada and USA.
4.6 Proposed strategy:

ICT in digital age can be leveraged for mobilization of intelligence in a networked world. We can create great value to the learning community of students and teachers by adopting strategies that profit from intelligence migration.

Principles of Value creation in the proposed strategy:

Value can be created through:

**Aggregation** of learning objects through a shared pool of educational resources and infrastructure. Strategic actions proposed in this thesis that we should have open access to educational portals with accredited, appropriate and accessible content meets this objective.

**Arbitrage** of knowledge from experts, centers of excellence and the end users themselves through a networked community of stakeholders facilitates migration of intelligence and knowledge from diverse sources. Networking of schools with shared resources meets this objective.

**Rewiring** the connections between diverse set of stakeholders [students, parents, teachers, educationists, subject matter experts, schools, colleges, universities, Government bodies, industries and NGO's] helps us to create value by sharing knowledge and best practices. Blended learning in conjunction with above two strategic actions facilitates rewiring of connections through an information exchange for the benefit of all stakeholders.
Teachers can be innovative in reassembling the modular learning objects from diverse sources through aggregation, reorganizing and configuring different pieces of learning objects into a coherent, personalized package for students depends on the learner, the content and the context. This gives ample scope for teachers to be creative and to enhance learning experiences of students. Further, students can pursue self-directed learning and choose the most appropriate learning style by themselves through reassembling of learning objects from diverse sources.

The proposed strategy is derived from the strategic vision and purpose that every student should have the opportunity to learn with smile and achieve his/her full potential.

The strategic objectives are:

1. Enjoy learning
2. Active learning
3. Learning how to learn
4. Collaborative learning
5. Learning opportunities for all

Learning environment that facilitates the schools to meet the objectives mentioned above should be:

1. Simple
2. Motivating
3. Interactive
4. Learner centric
5. Collaborative.

Key elements of the strategy to meet the strategic objectives:

1. Teacher
2. Content
3. Access
4. Technology
5. Collaboration

Strategic actions required to create and share the SMILE:

1. Educational portal with accredited, appropriate and accessible content.
2. Networking of educational institutes with shared resources
3. Blended learning with flexible curriculum and assessment
4. Center for excellence in educational technologies

Benefits from strategic actions:

1. Learning flexibility
2. Learning to share and sharing to learn
3. New ways of learning
4. Innovation in teaching and learning
4.7 Hypothesis:

4.7.1 Learning environment:

Learning environment in which students enjoy learning and learn with understanding should be:

- Simple
- Motivating
- Interactive
- Learner centric
- Collaborative

4.7.2 Key elements of the strategy:

Teacher:

- Teacher plays a very important role in making learning a joyful experience.
- Teacher will be at the heart of transformation in learning to facilitate every student to enjoy learning and achieve his/her full potential

Content:

- Access to accredited, enriching content is important to enjoy learning.
- Media rich, accredited content such as simulations and animations helps teachers to be innovative and creative
Access:

- Broadband access to internet is essential for more ways of learning.
- Programs such as EDUSAT, which provide video lectures of expert teachers are highly useful.

Technology:

- Technology can make learning more joyful, interactive and collaborative.
- Technology provides tools to enhance classroom experience and share knowledge

Collaboration:

- Chat, discussion forums helps in learning together and sharing of knowledge.
- Collaboration helps in sharing best practices and innovate ways of teaching

4.7.3 Strategic actions:

Educational portals with open access:

- Portals with open access are extremely valuable to both students and teachers.
- Educational portals with accredited and relevant content such as BBC and WonderWhizKids are highly useful.
Networking of schools:

- Networking of schools to share content and experience of teachers is important.
- Networking of schools to collaborate and share the learning modules and best practices of other schools is important.

Blended learning with flexible curriculum and assessment:

- Students can have more flexibility in learning if classroom learning is combined with online learning.
- Flexibility in curriculum and assessment facilitates teachers to be more creative in meeting diverse learners needs.

Center for excellence in educational technologies (training):

- Training for familiarity with computers, internet and other tools like Google and Wikipedia is important for improved learning.
- Training for familiarity with computers, internet and other software tools is important for innovation in teaching.
4.7.4 Benefits of the strategy:

Enjoy learning:

- We enjoy learning if it is made simple and easy to understand.
- Teaching with the aid of multimedia presentations makes learning interesting and engaging.
- Explaining the concepts with simple, interesting facts relevant to the world around us is important.
- Explaining the concepts through visual presentations to make learning simple and easy is useful.
- Multimedia presentations, which make learning interesting and motivating are useful.
- Students enjoy learning if teacher explains the subject matter through simple concepts and interesting facts related to social context of the learner.
- Teaching with the aid of multimedia presentations makes learning interesting and engaging.
- Content structuring and sequencing to move from simple to increased levels of complexity is important. Images and pictures centered around a theme along with animations to explain concepts are important.
- Students enjoy learning with simple and easy to understand images, graphics, animations and simulations and hence are considered useful.
- Games that simulate applications in real life, which make learning interesting while being relevant and meaningful, are useful.
Active learning:

- Interactive simulations improve understanding of difficult concepts and stimulate creative thinking.
- Students should have the flexibility to learn anytime, anywhere at his own pace, to suit his learning preferences.
- Online quizzes with worked out examples and solutions to improve confidence and satisfaction are important.
- Interactivity in e-Learning, which facilitates learning by doing is important.
- Interactive applets and animations to explain difficult concepts are useful.
- Interactive simulations help students to develop curiosity and critical thinking.
- Simulations of experiments difficult to perform in lab such as total internal reflection are important.
- Interactive simulations to explain concepts like Interference and Polarization are useful.

Collaborative learning:

- Sharing knowledge with friends while doing projects on internet, which provides more learning opportunities is important.
- Educational portals with open access, which extends learning opportunities to all are useful.
- Shared resources including online libraries and educational portals help teachers to be more innovative.
• Collaboration among schools in sharing best practices in teaching and content is important.
• Virtual classrooms, which extend the reach of expert teachers and facilitate learning for wider audience are useful.

Learning how to learn:

• Online learning, which helps in learning to learn through search engines such as Google, Wikipedia and educational portals such as BBC is important.
• Online learning, which offers flexibility to students to learn how to learn with their preferred learning style is useful.
• Exploring the subject through educational portals and other online sources such as Wikipedia for doing projects facilitates learning to learn in students.
• Flexibility in learning through access to varied but accredited content from open source such as BBC is important.
• Quizzes along with worked out solutions that enable learners to assess their own understanding are useful.

4.8 Main Study:

The main study was conducted in six secondary schools in Hyderabad, three of them are following central board syllabus, two of them following State board syllabus and the remaining one following ICSE syllabus.
4.9 Survey:

Conducted a survey with representative sample of teachers and students from private as well as government schools to examine the opinions and preferences of students and teachers in creating a learning environment that facilitates learning with smile, learning with understanding and learning how to learn enabling life long learning.

Conducted a workshop on “The implementation of SMILE and its benefits” with the aid of Wonderwhizkids portal\(^1\),\(^2\). An intense and interactive discussion on a selected topic in physical sciences has been carried out in schools for three to four hours. Multimedia presentations like applets and animations have been extensively used to explore and explain the subject matter. Real world applications of the concepts have been elaborated during the workshop. Students have actively participated in exploring and understanding the subject matter. All the students and teachers who participated in the workshop were given a questionnaire at the end of the workshop to elicit their opinion on SMILE.

4.10 Survey Objectives:

- Identify good practices for creation of a learning environment in which students enjoy learning.
- Student feedback on views regarding attributes of a learning environment in which students enjoy learning and learn how to learn.

\(^1\) A. Vidya Sagar. Implementation of Non-linearity and Interactivity in e-Learning. National seminar on e-Learning, ELELTECH INDIA, 2005. (The published article is given in Appendix F)

\(^2\) A. Vidya Sagar. E-Learning strategy in "Wonderwhizkids" - a science portal. Indian Journal of Training and Development. April – June, 2006. (The published article is given in Appendix G)
Teacher feedback on views regarding attributes of a learning environment in which students enjoy learning and learn how to learn.

Identify strategic action points.

4.1 Survey instrument topics:

Information relating to student / teacher /school

- Attributes of learning environment in which students enjoy learning.
- Importance of content, access, technology and collaboration in enhancing the learning experience.
- Role of a teacher to facilitate learning with smile.
- Management strategies to create a learning environment, in which students enjoy learning, learn how to learn and learn with understanding.

4.12 Activities:

- Questionnaire design
- Survey of schools
- Interview with Head-teacher/Principal
- Group discussion with students
- Group discussion with staff
- Completion of Questionnaires
- Analysis of responses
4.13 Wonder Whiz Kids:

No one knows exactly what the future holds, but there is little doubt that computing technology will be a large part of it. Young people will be using technology directly as a basic part of their employment. Beyond the workplace, as citizens they will need to understand technology's products, interpret information, and choose from ideas that inundate their lives. Skilled use of technology will be an important part of their future, but more important is the skillful use of their minds. This skilled use of minds would definitely, in a large part, call for strong basics. A grasp on fundamentals that students don't go back to now and then but takes them forward for a better life.

Barriers to effective learning:

Web-based learning faces motivational challenges due to lower levels of interactivity and isolated feeling of learners as compared to classroom environment where interactions with the teacher and other students are very high. We need to address these challenges in on-line learning by actively involving students through an interactive environment. A successful solution shall be simple and make them effectively relate their knowledge in real world situations. So, the challenge is to create an environment, which is simple, motivating and interactive.

WWK Making the Difference:

Wonder Whiz Kids is a science portal for students who want to gain conceptual understanding and improve their performance in school. The higher open-ended goal is to
develop a scientific worldview. Wonder Whiz Kids helps children to experience a sense of belonging to a large family of life with respect and love for ‘Nature’ and its beings.

Wonder Whiz Kids” creates an inquiry based, interactive learning environment to acquire knowledge and gain insight. WWK is for students of age 12 years and above, parents, teachers and all those who are interested in promotion of science and scientific thinking. The main features of this portal are visualization, concept related content sequencing, interactive and collaborative learning, self-assessment, games and simulations. The content would be simple, interesting and interactive to sustain and enhance the span of attention while helping the student to understand the fundamental concepts of science and learn to apply them gainfully in real world situations.

Purpose:

Making Science Fun, Making Students Lifelong Science Learners:

In order to make students lifelong science learners we endeavor to present content incorporating the following facets:

- Interactive Element
- Thematic Exploration
- Contextual Base
- Concept Clustering
- Positive Feedback
- Future Direction
- Visualization Tools
- Gaming nature
Student goals:

- Understanding scientific principles / concepts in an engaging way.
- Learn to apply the concepts - Know why?
- Visualize the process and elements of science - Applets, Animations.
- Set the feedback - Q & A.

Product perspective:

- Self – Directed
- Self – paced learning
- Interactive
- Collaborative
- Self assessment
- Examples and Applications
- Non-linearity

Content Structure:

The content is structured in a manner that enhances long-term retention. This portal helps students in

- Firm understanding of the basics of the subject.
- Think critically.
- Ready to apply the concepts to real world problems.
Summary of capabilities:

- Grasp of fundamentals.
- Interactive learning through applets / animations.
- Shared knowledge - Chat.
- Self assessment - Q&A
- Applications - Know why

Product Features:

The following table 4.1 details the feature list mapped against the three aspect of above definition: absorption, retention and performance. The technology has been selected in keeping with the delivery of the features in an integrated learning environment.
<table>
<thead>
<tr>
<th>OBJECTIVE</th>
<th>FEATURE</th>
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<tbody>
<tr>
<td>Enjoy learning</td>
<td>Visualisation through</td>
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<tr>
<td></td>
<td>Graphics</td>
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<tr>
<td></td>
<td>Images</td>
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<td>Animations</td>
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<td></td>
<td>Absorption through</td>
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<td>Themes</td>
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<td></td>
<td>Analogies</td>
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<td>Examples</td>
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<tr>
<td>Active Learning</td>
<td>Applets</td>
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<td>Animations</td>
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<td></td>
<td>Projects</td>
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<td></td>
<td>Know Why</td>
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<td></td>
<td>Explore</td>
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<td></td>
<td>Q &amp; A for Self assessment</td>
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<td></td>
<td>Games</td>
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<tr>
<td>Learning how to learn</td>
<td>Non linear Course material</td>
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<tr>
<td></td>
<td>Concept Related</td>
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<td></td>
<td>Learner Related</td>
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<td></td>
<td>World Related</td>
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<td></td>
<td>Utilization Related</td>
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<td></td>
<td>Explore with</td>
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<td>Search</td>
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<td></td>
<td>Hyperlinks to useful portals</td>
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<td>Key words</td>
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<tr>
<td>Collaborative learning</td>
<td>Chat</td>
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<td></td>
<td>Discussion forums</td>
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<td>Conference</td>
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<td></td>
<td>Contribute</td>
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<td></td>
<td>Ask the expert</td>
</tr>
</tbody>
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Table 4.1
Contextual Base:

Providing the concepts with the relevant real world examples (eg: Explore, Know Why) is a sure way to fire student's imagination. Relevant examples are provided wherever possible to motivate the student and make learning meaningful.

Visualization Tools:

Animations would be far expressive of an abstract concept than the same explained on a blackboard. As the medium is not limited to the 3rd dimension, presenting material as it occurs in 2d/3d is educative. Lab is another tool incorporated where one can see a reaction in action than just imagine while being taught. In flash animations, the ability of carbon atom to undergo different types of hybridization to form millions of organic compounds is clearly demonstrated (Figure 4.1 is a screenshot of the animation of hybridization in Carbon).

Interactive Element:

Many multimedia products are nothing more than electronic books. The value of multimedia comes when we offer students a greater role in the acquisition and analysis of information.
A full scale multimedia experience would call for video footage, audio support, drag and do tools etc. We have tried to find ways to engage rather than diminish the user experience by resorting to the glorified page-turning tradition. E.g. Lab, Carbon Movie, Projects.

Gaming Nature:

Gaming nature makes the educative process fun. And it is this thought we have tried to capture in the game room, which contains Crosswords, Memory Cards etc. Topic-wise crossword games are built in the site. Eg: Carbon compounds, Carbon reaction, Nature of light etc. Figure 4.2 is a screenshot of a crossword game. A flash-based game on the topic “Nomenclature of organic compounds” is built to give a practice to the students on naming the vast number of organic compounds.

Simulations:

WWK developed simulations for standard experiments and animations for basic concepts. Since context and practice are two keys in retaining and applying knowledge, simulations provide a means for the student to have hands-on experience without the costs or risks involved in working in a “live” environment. In e-Learning, simulations strive to recreate the student’s work environment. They solve three primary purposes that regular lab experiments cannot provide.
Better visualization: Experiments may not always clearly demonstrate what happens within the apparatus as it is closed. Students mostly see the end results. Simulations on the other hand can be used to demonstrate the effects in all stages.

For example: Figure 4.3 is a screenshot of the simulation of Polarization of light rays. How unpolarized light becomes polarized when it is sent through a polarizing sheet or filter and what exactly happens to the light rays can be visualized the students can experiment with different positions of two filters. In a live experiment, what the student gets is the emerging ray and what happens to the different components of the light ray has to be assumed by the student. But here in this simulation, all these concepts can visualized by the student.

Figure 4.4 is a screenshot of another simulation. In this simulation the position and size of the image formed by a convex lens for different positions of an object are clearly shown. Student can vary the distance of the object from the lens. The numerical calculation of the distance of the image from the lens is also displayed dynamically in the simulation.
Approximations and varying initial conditions:

In lab experiments, students aim is to reproduce the ideality and verify the theoretical values. However, many times the students will benefit and gain an overall understanding of the process if he/she can change the initial conditions or the environment.

For example, let us consider a refractive index experiment. Typical lab experiments are aimed at measuring the refractive index of a medium (water, alcohol or some other liquid). But, if the student must understand the effect of the density of the medium or the wavelength of the incident light on refractive index, constructing lab experiments will be extremely cumbersome and time consuming. Figure 4.5 is a screenshot of simulation of refraction of light rays.

However, through a simulation these changes can be easily implemented and the student will gain the ability to approximate.

- Experiments that are impossible to perform in real world:

All our simulations are applets. An applet is a little application. On the web, an applet is a small program that can be sent along with a web page to a user. E.g. Java applets can
perform interactive animations, immediate calculations, or other simple tasks without having to send a user request back to the server.

Positive Feedback:

One of the most important educational components is the assessment of the student's acquired knowledge. Self assessment provides the means of evaluating the student's acquired knowledge and valuable feedback regarding his performance (the grade, a bar graph, the correct answers etc).

Self assessment (herein after referred to as SA in the text) is a highly dynamic component of the WonderWhizKids methodology, involving both synchronous and asynchronous communication between students and instructor. In order to build a model of SA, we analyzed the assessment process, different possible scenarios, relationships between different concepts and different assessment types.

We have concentrated on not just providing whether a student has passed or failed, but the areas where he/she is strong or weak. The question thrown would be from a database that generates random question rather than in a sequential stream. This would keep the interest to take the next test not only alive but interesting tool.
Benefits of technology enabled blending learning:

Integrating class room learning with WWK:

Technology can make learning more interactive, enhance the learning experience and facilitate collaborative learning. The effectiveness of technology enabled learning experience depends on the design of the application and the instructional methods including content structuring and sequencing. E-tools like Flash animations, Java applets promote visualization of concepts and help students gain insights through interactive simulations. Retention can be enhanced through clear understanding of the concepts and their applications in real world situations. Non-linearity in content sequencing enables interactive, flexible learning along with application of concepts in everyday life through features like keywords, search and explore. The access to WWK is free. WWK invites students and teachers across the world to become part of this community to collaborate and contribute. Controlled experiments are yet to be conducted in schools to evaluate the effectiveness of the portal in enhancing the performance of students and meet their intrinsic needs to know and learn about the world we belong to. Wonder Whiz Kids creates SMILE by integrating cognitive, constructive, experiential and motivational learning theories.

4.14 Sampling Method:

The list of educational institutions offering secondary education was gathered. Ten institutes were selected randomly. The researcher personally approached each of these institutes, briefed them about the research study and sought their willingness to participate in
the study to enable the researcher to collect data. Finally six educational institutes participated in the study.

The data was collected from students studying in 8th to 12th standard. Similarly data is collected from teachers of 8th to 12th standard.

4.15 Profile of participated Educational Institutes:

Kendriya Vidyalaya, Trimulgherry (herein after referred to as KVT in the text), Secunderabad - An institution par excellence imparting academic training and guidance to the students of Secondary and Senior Secondary level aiming at total development and academic excellence. It was started in the year 1963. KVT is one of the initial Vidyalayas of Kendiya Vidyalaya Sangathan. Since then its march has been a passionate saga of ambition, vision, commitment and life. It has seen a tussle between hope & despair, a yawn here and a hiccup there. These best of daunting circumstances only came to inspire, to soldier on with faith and courage. Today KVT is 2800 strong with 98 Staff members occupying an exclusive niche on the National KVS Map.

Bharatiya Vidya Bhavan - Bhavan's Sri Ramakrishna Vidyalaya, Sainikpuri, Secunderabad. The school commenced on 15th June 1974. The school is affiliated to the Central Board of Secondary Education, New Delhi and is a pioneer institution in the twin cities. It has a hundred sections in all its classes put together, from LKG to class XII. It is maintaining a record of 100% results in the class X board exams since 1982. In keeping with the spirit of the Bharatiya Vidya Bhavan, the school believes in a holistic approach to learning, giving equal importance to academics, sports and other creative pursuits. In the
thirty two years of its existence the school has strived and is still doing its best to promote overall excellence in all the students coming into its portals.

Gitanjali Devshala, Secunderabad is a branch of the Gitanjali School, Begumpet. It was started in June 1997 has classes from Nursery to class X. It follows the ICSE curriculum. The school has grown rapidly and has earned the name of being one of the most prestigious schools in the twin cities of Hyderabad and Secunderabad, as the curriculum is rich, standard is high and the classes are small. The school is committed to personalised teaching. The school aims to give to students a balanced variety of educational, social and cultural experiences to prepare them for life. The qualified and experienced staff believe in challenging their own abilities as well as the abilities of their students. They are always in search of new ideas adapted to the demands of the changing times. The staff-student ratio is 1 is to 18. The school aims at developing the total personality of the child to make a better citizen of tomorrow, by imbibing in him the qualities of leadership, reverence for Indian culture, regard for elders and respect for the noble ideas and norms of society.

Orchids – The International School provides high quality learning in a very carefully structured, positive and caring environment that meets every child's needs. Though the school follows the CBSE curriculum, it offers an option at Class VII for students to opt for the International curriculum, viz. IGCSE / International Baccalaureate programs extending up to Class XII, providing students with an avenue to compete Internationally. Each class has computers, interactive material related room facility where the child need not follow the conventional method of learning. At Orchids, apart from the regular teaching and learning process the students are given a practical experience. They have teaching aids, like every classroom is connected to the Internet where students can access it at any time, to give them
a better learning system. At Orchids International School every child receives special attention by the teachers to ensure academic growth and also help the child to appreciate the "art of learning by doing".

Vignan Vidyalayam, Nizampet - Vignan is one of the largest educational groups of Andhra Pradesh. Vignan Group established in the year 1977 has grown by leaps and bounds in its three-decade journey towards excellence. Vignan schools follow SSC syllabus. The institutions of Vignan Group are well known for their discipline, dedication and academic excellence. Vignan, Nizampet branch offers classes from Nursery to class X and has unparalleled track record since inception with 99% success rate. Vignan is synonymous with excellence in educational standards and is looked upon as a value based credible organization.

Gautam Vidyaniketan High School is a private school following SSC syllabus. It has a strength of 600 students and 25 staff members. It has classes from LKG to class X. Gautam Vidyaniketan aims to provide quality education to students and has 100% success rate. The school is committed to enhance knowledge levels of students.

4.16 Data collection procedure:

As the selected educational institutes offer secondary education, random sampling method is adopted to collect data from the students to avoid sampling bias. A letter, which explains the purpose of the research study and a confirmation to keep the names of the participants confidential, was enclosed along with each questionnaire. The student questionnaires were handed over to the respective class teachers of all the six educational institutes participated
in the study. They in turn distributed the questionnaires to the students with an advice to self-administer the questionnaires. It was requested that questionnaires be filled at a stretch. They were also asked to return the filled in questionnaires to the class teacher. The researcher offered support / clarifications if needed by them. It was assessed that the students took 20 – 25 minutes to fill in the questionnaire. The researcher collected the filled in questionnaires from the class teachers. There were totally 1500 questionnaires distributed and 1470 filled in questionnaires were received back. Out of 1470 filled in questionnaires, one questionnaire was found blank and the other two were not having proper data. Hence 1467 filled in valid questionnaires were used in the study, thus getting a 97.8% rate of return. It took one month to complete the final study in six educational institutes.

Data is collected from schools offering secondary and higher secondary education. The data is in the form of questionnaires addressed to student and teachers from Government as well as private schools. Some of the schools are following central syllabus (CBSE/ICSE) where as other are following state syllabus of Government of Andhra Pradesh. A total of 1487 valid questionnaires are selected from students of different schools; while 107 teachers from the same schools gave their opinion on various aspects of learning in schools by answering the questionnaire provided to them.

4.17 Data analysis Procedure:

The data collected using the structured questionnaires for students and teachers were checked for inconsistencies and computerized by creating structure in standard database package (MS-Access). Quantitative analysis of data has been carried out using the statistical software, Statistical Package for Social Scientists (SPSS Version 10.0) and basic frequency
tables and bi-variant cross-tabulations for selected variables have been generated. For example, cross-tabulations were run to study the association between variables related to learning environment (SMILE), benefits, strategic objectives and key elements of the strategy.

Analysis of data collected from students:

Data collected from all the 1467 students from various Government as well as private schools by using questionnaire were analysed for appropriate grouping of similar factors. Data has been grouped as key elements of strategy, benefits of the strategy /strategic objectives, strategic actions, and the proposed strategy (share the SMILE) and the results are presented in the form of bar charts.

Reliability:

Cronbach’s coefficient “Alpha” of reliability has been computed for the questionnaire collected from students and teachers. The alpha co-efficiencies are computed for aggregate sample (n = 1467 in case of students and n=107 in case of teachers). The alpha value 0.73 obtained for students and 0.732 obtained for teachers indicates the high internal consistency of the questionnaire used in the study.

4.18 Tests Employed:

Binary logistic regression:

Binary logistic regression models are widely used in applied research, as many outcome variables (dependent variables) will be binary or dichotomous (consisting of only two possible
observations). Binary logistic regression is a technique for predicting the mean value of a binary response variable as a function of one or more covariates. Advanced statistical tools such as binary logistic regression have been used for identifying causal relationships between/among variables of interest.

Binomial (or binary) logistic regression is a form of regression, which is used when the dependent is dichotomy and the independent variables are of any type (categorical or continuous variables). In other words, logistic regression is designed to describe probabilities associated with the values of the response variable. Logistic regression can be used to predict a dependent variable on the basis of continuous and/or categorical independents and to determine the percent of variance in the dependent variable explained by the independents; to rank the relative importance of independents; to assess interaction effects; and to understand the impact of covariate control variables.

Binary logistic regression is often chosen if the predictor variables are not nicely distributed. Logistic regression makes no assumptions about the distributions of the predictor variables. Logistic regression has been especially popular with medical research in which the dependent variable is whether or not a patient has a disease. Binary logistic regression is a technique for predicting the mean value of a binary response variable as a function of one or more covariates. For example, a questionnaire may record Yes/No answers to a particular question. Both of these responses are examples of binary variables. Ordinary regression cannot safely be applied to this kind of response variable. The variance of a binary (or Binomial) variable is not constant. In addition, an ordinary regression approach would yield predicted values, which lie outside the range of feasible values for the dependent variable.
Instead, logistic regression models the probability of a positive response (e.g., a 'Yes', or 'disease occurrence') given the values of other variables.

Logistic regression applies maximum likelihood estimation after transforming the dependent into a logit variable (the natural log of the odds of the dependent occurring or not). In this way, logistic regression estimates the probability of a certain event occurring.

**Logistic Regression Model:**

\[
\text{logit}(\pi) = h_0 + b_1 X_1 + b_2 X_2 + \ldots + b_n X_n
\]

where, \( \text{logit}(\pi) = \log \left( \frac{\pi}{1-\pi} \right) \) = logit transformation of the probability of the event

- \( h_0 \) = intercept of the regression line
- \( h_1, h_2, \ldots, h_n \) = parameters of the regression line
- \( \pi_i \) = is the probability the event occurs in the \( i \)th case.

In SPSS, binomial logistic regression is under Analyze - Regression - Binary Logistic, and the multinomial version is under Analyze - Regression - Multinomial Logistic.

The success of the binary logistic regression can be assessed by looking at the classification table, showing correct and incorrect classifications of the dichotomous dependent variable.

The form of the logistic model is:

\[
\log_e \left\{ \frac{p(y)}{1-p(y)} \right\} = \beta X \quad \ldots..(1)
\]
where \( p(y) \) = the probability of a positive response. The term on the left-hand side of equation (1) is called the logit or log-odds of \( p(y) \). The quantity within the curly brackets represents an odds value (i.e. the ratio of the probability of a positive response to the probability of a negative response). In the terminology of generalized linear models, the logit is the link function i.e. \( \eta(p) = \log\left(\frac{p}{1-p}\right) \). Thus, on the logistic scale, the logit is related to the explanatory variables by a linear model. On the data scale, the relationship between \( p(y) \) and the explanatory variables is non-linear and takes the form:

\[
p(y) = \frac{\exp(BX)}{1+\exp(BX)} \\
\]

The function (2) is called the logistic function. As \( x \) tends to minus infinity, \( p(y) \) tend to 0. As \( x \) tends to plus infinity, \( p(y) \) tends to 1. In between, the curve takes on an S shape, tapering off asymptotically at both ends of the range of \( x \).

Odds Ratio

The Variables in the Equation output also gives us the \( \exp(B) \). This is better known as the odds ratio predicted by the model. This odds ratio can be computed by raising the base of the natural log to the \( b \)th power, where \( b \) is the slope from our logistic regression equation.

Logistic regression computes the log odds for a particular outcome. The odds of an outcome are given by the ratio of the probability of it happening and not happening as \( \frac{P}{1-P} \), where \( P \) is the probability of an event. There are some mathematical problems in reporting these odds, so natural logarithms (\( \log e \)) of these odds are calculated. These values may vary from infinite to + infinite. A positive value indicates that odds are in favour of
the event and the event is likely to occur while a negative value indicates that odds are against the event and the event is not likely to occur.

Maximum likelihood estimation, MLE, is the method used to calculate the logit coefficients. MLE seeks to maximize the log likelihood, LL, which reflects how likely it is (the odds) that the observed values of the dependent may be predicted from the observed values of the independents. MLE is an iterative algorithm, which starts with an initial arbitrary "guesstimate" of what the logit coefficients should be. The MLE algorithm determines the direction and size change in the logit coefficients, which will increase LL. After this initial function is estimated, the residuals are tested and a re-estimate is made with an improved function, and the process is repeated (usually about a half-dozen times) until convergence is reached (that is, until LL does not change significantly). There are several alternative convergence criteria.

Method of selecting variables:

A researcher, often, may not know just which subset of variables constitutes a good model. For such instances, SPSS provides several methods for controlling the entry or removal of independent variables from the regression model.

Forward selection is the usual option, starting with the constant-only model and adding variables one at a time in the order they are best by some criterion (see below) until some cutoff level is reached (ex: until the step at which all variables not in the model have a significance higher than .05).
Interpreting Logits:

Logit coefficients (logits), also called unstandardized logistic regression coefficients or effect coefficients or simply "parameter estimates" in SPSS output, correspond to b coefficients in OLS regression. Both can be used to construct prediction equations and generate predicted values, which in logistic regression are called logistic scores. The SPSS table which lists the b coefficients also lists the standard error of b, the Wald statistic and its significance, and the odds ratio (labeled Exp(b)) as well as confidence limits on the odds ratio. Odds, odds ratios, and logits are all important basic terms in logistic regression. In general, a logit is a "parameter estimate" in SPSS output, but it is easier to interpret when converted to an odds ratio using the exp(b) function, where b is the logit. That is, an odds ratio is the base of the natural logarithm, e, raised to the power of the logit. Logits (log odds) are the natural log of the odds ratio, expressed as ln(odds ratio). Where OLS regression has an identity link function, logistic regression has a logit link function (that is, logistic regression calculates changes in the log odds of the dependent, not changes in the dependent itself as OLS regression does).

For the dichotomous case, if the logit for a given independent variable is b1, then a unit increase in the independent variable is associated with a b1 change in the log odds of the dependent variable (the natural log of the probability that the dependent = 1 divided by the probability that the dependent = 0). In SPSS output, the logits appear in the "B" column of the "Variables in the Equation" table. In summary, logits vary between plus and minus infinity, with 0 indicating the given explanatory variable makes no difference in the probability of the dependent value equaling 1 (or 0 either) for the bivariate logistic regression case. The value
of the logit is the value of the change in the log odds of the dependent variable per unit change in the predictor variable, positive or negative.

**Odds ratio**: The most common way of interpreting a logit is to convert it to an odds ratio using the \( \exp() \) function. One can convert a logit back to an odds ratio using the \( \ln() \) function. Note that an odds ratio above 1.0 refers to positive odds that the dependent = 1 in binary logistic regression. The closer the odds ratio is to 1.0, the more the independent variable's categories (ex: male and female for gender) don't matter and are independent of the dependent variable, with 1.0 representing full statistical independence. For instance, if the logit \( \beta_1 = 2.303 \), then the corresponding odds ratio (the exponential function, \( e^\beta \)) is 10, then we may say that when the independent variable increases one unit, the odds that the dependent = 1 increase by a factor of 10, when other variables are controlled. In SPSS, odds ratios appear as "Exp(B)" in the "Variables in the Equation" table.

**Effect size**: The odds ratio is a measure of effect size. The ratio of odds ratios of the independents is the ratio of relative importance of the independent variables in terms of effect on the dependent variable's odds. (Note standardized logit coefficients may also be used, as discussed below, but then one is discussing relative importance of the independent variables in terms of effect on the dependent variable's log odds, which is less intuitive).

**Goodness of fit**: How well the data are modeled by that distribution is known as goodness-of-fit. In general, extra work is needed to obtain a quantitative measure of the goodness-of-fit, and there is no universally accepted mathematical definition, which is valid in all cases.
If chi-square goodness of fit is not significant, then the model has adequate fit. By the same token, if the test is significant, the model does not adequately fit the data. It is available under the Options button in the SPSS binary logistic regression dialog. The test divides subjects into deciles based on predicted probabilities, then, computes a chi-square from observed and expected frequencies. Then a probability (p) value is computed from the chi-square distribution with 8 degrees of freedom to test the fit of the logistic model. The Hosmer and Lemeshow Test provides a formal test for whether the predicted probabilities for a covariate match the observed probabilities. That is, goodness-of-fit (Hosmer and Lemeshow) test is used to test the null hypothesis that the binary logistic model fits well to the data. For a given chi-square value obtained from the Hosmer and Lemeshow test, if the probability p shown in the SPSS output is > 0.05 (level of significance), we can accept null hypothesis. This means, binary logistic model fits well to the data. Otherwise, we reject null hypothesis, indicating that binary logistic regression does not fit well to the given data. A large p-value indicates a good match. A small p-value indicates a poor match, which tells you that you should look for some alternative ways to describe the relationship between this covariate and the outcome variable.

**Test of Significance:** For binary logistic regression with dichotomous independents, the Wald statistic is the squared ratio of the unstandardized logit coefficient to its standard error. The Wald statistic and its corresponding probability level (p) is part of SPSS output in the "Variables in the Equation" table. To test whether the independent variables have significant influence on the dependent variable, we compare the p values with the level of significance (usually, 0.05). If the p value of a particular variable is less than 0.05, we conclude that the independent variable has significant influence on the dependent variable. If p ≥0.05, we
conclude that the influence of the variable is statistically insignificant. The researcher may well want to drop independents from the model when their effect is not significant.

Confidence Interval on the odds ratio: SPSS labels the odds ratio "Exp(B)" and prints "Low" and "High" confidence levels for it. If the low-high range contains the value 1.0, then being in that variable value category makes no difference on the odds of the dependent, compared to being in the reference (usually highest) value for that variable. That is, when the 95% confidence interval around the odds ratio includes the value of 1.0, indicating that a change in value of the independent variable is not associated in change in the odds of the dependent variable assuming a given value, then that variable is not considered a useful predictor in the logistic model.

Application of Binary Logistic Regression for the research data: Binary logistic analysis was applied using SPSS on the data collected from 1467 students from different schools as the sample size is large enough to give reliable results. Advanced statistical analysis like binary logistic regression results may not give reliable results if the sample size is small. Hence data collected from teachers (n=107) was considered for computing frequency tables and bi-variate cross-tabulations.

Binary logistic regression models were run on the data collected from students using SPSS in order to study the relationship/influence of

(i) key elements of strategy and strategic actions on learning environment (SMILE),
(ii) learning environment (SMILE) on benefits of strategy, strategic objectives,
(iii) key elements of strategy and strategic actions on benefits of strategy/ strategic objectives.
The questionnaires for students captured the stakeholders' perceptions on learning environment (SMILE), benefits and factors that contribute to benefits. The answers to the questions on the above aspects were measured in a five-point scale. Table 4.2 shows the stakeholders' perceptions on learning environment (SMILE).

**Table 4.2 Stakeholders' perceptions on learning environment (SMILE)**

<table>
<thead>
<tr>
<th>Description of variable</th>
<th>Response codes</th>
<th>Converted codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables related to opinion on learning environment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Agree</td>
<td>1. Agree, if response code is 1 or 2</td>
<td></td>
</tr>
<tr>
<td>2. Slightly agree</td>
<td>2. Disagree, if response code is either 3 or 4 or 5</td>
<td></td>
</tr>
<tr>
<td>3. Neither agree nor disagree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Slightly disagree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Disagree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables related to benefits of sharing SMILE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Enjoy learning if it is made simple and easy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Teaching with the aid of multimedia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Interactive simulations improve understanding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Students should have the flexibility to learn anytime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables related to strategic objectives:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Very important</td>
<td>1. Important, if response code is 1 or 2</td>
<td></td>
</tr>
<tr>
<td>2. Important</td>
<td>2. Not important, if response code is either 3 or 4 or 5</td>
<td></td>
</tr>
<tr>
<td>3. Can't say</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Not important</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Not at all important</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables related to strategic objectives:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Highly useful</td>
<td>1. Useful, if response code is 1 or 2</td>
<td></td>
</tr>
<tr>
<td>2. Useful</td>
<td>2. Not useful, if response code is either 3 or 4 or 5</td>
<td></td>
</tr>
<tr>
<td>3. Can't say</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Not useful</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Not at all useful</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
When frequency tables were generated for all the qualitative variables listed above, majority of the responses were clustered in one or two categories. Hence it was decided to convert the responses/codes for each qualitative variable from five-point scale to dichotomous responses (as shown in column 3 of the above table) in order to study the relationship among variables of interest using binary logistic regression.

The author has identified several variables relating/corresponding to the benefits like enjoy learning, active learning, learn to learn and collaborative learning. For example, if we look at the data collected from students, 'enjoy learning' can be assessed by combining several related variables, viz., enjoy learning if it is made simple and easy (Q11_1), teaching with the aid of multimedia presentations makes learning interesting and engaging (Q11_2), explaining the concepts with simple, interesting facts (Q12_1), explaining the concepts through visual presentations to make learning simple and easy (Q13_1), and multimedia presentations, which make learning interesting and motivating (Q13_2). Therefore, a new variable 'enjoy learning' was derived by adding the related variables which measure 'enjoy learning' indirectly. In the similar fashion, other new variables like active learning, learn to learn and collaborative learning has been derived by combining related variables separately. Table 4.3 gives the details of the variables relating/corresponding to the benefits of Strategy.
Table 4.3  Variables relating/corresponding to the benefits of Strategy

<table>
<thead>
<tr>
<th>Study tool</th>
<th>Benefits</th>
<th>Variables related to the benefits</th>
<th>Derived variables</th>
<th>Range of scores of derived variables</th>
<th>Median n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students questionnaire</td>
<td>Enjoy learning</td>
<td>Q11_1; Q11_2; Q12_1; Q13_1; Q13_2</td>
<td>Enjoy learning: Q11_1 + Q11_2 + Q12_1 + Q13_1 + Q13_2</td>
<td>(0, 1, 2, 3, 4, 5)</td>
<td>5</td>
</tr>
<tr>
<td>Active Learning</td>
<td>Q11_3; Q12_2; Q12_3; Q13_3</td>
<td>Active Learning: Q11_3 + Q12_2 + Q12_3 + Q13_3</td>
<td>(0, 1, 2, 3, 4)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Learn to learn</td>
<td>Q11_4; Q12_4; Q13_4</td>
<td>Learn to learn: Q11_4 + Q12_4 + Q13_4</td>
<td>(0, 1, 2, 3)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Collaborative Learning</td>
<td>Q12_5; Q13_5</td>
<td>Collaborative learning: Q12_5 + Q13_5</td>
<td>(0, 1, 2)</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

The scores of the newly derived variables will be computed by adding the individual scores of the related (dichotomous) variables, as shown in column 4 of the above table. Now the derived variables are non-dichotomous and assume values between 0 and n (where n=number of related variables added to derive a new variable). For example, the variable 'active learning' was derived by adding the four variables, viz., Interactive simulations improve understanding of difficult concepts (Q11_3), Online quizzes with worked out examples and solutions to improve confidence and satisfaction (Q12_2), Interactivity in e-Learning facilitates learning by doing (Q12_3), and Interactive applets and animations to explain difficult concepts (Q13_3). The minimum score for the variable 'active learning' will be zero, if all the addends have '0', and the maximum score will be 4, if all the addends have '1'. The range of scores assumed by the derived variables is presented in column 5 of the above table.
In order to convert the derived variables into dichotomous variables, the scores of the respective variables have to be converted into binary outcomes. We compute median scores for each derived variable and compare the individual scores with their respective median scores. If the individual score is less than median score, put score as '0', otherwise '1'.

Once all benefit variables (enjoy learning, active learning, learn to learn and collaborative learning) converted into dichotomous variables, we use advanced statistical tools (binary logistic regression) to study the relationship/influence of attributes of learning environment, key elements of strategy and strategic actions on the strategic objectives.

Binary logistic regression is also used to study the relationship/influence of key elements of strategy and strategic actions on the attributes of learning environment.