DEVELOPMENT OF SENSORY CARDS FROM BANANA STEM FIBRE FOR CHILDREN WITH LEARNING DIFFICULTIES

Dissertation submitted to

ST. TERESA'S COLLEGE (Autonomous)

ERNAKULAM

In partial fulfilment of the requirement for the award of the degree of

THE AWARD OF THE DEGREE OF MASTERS OF SCIENCE IN

M.Sc. HOME SCIENCE (BRANCH A) CHILD DEVELOPMENT

By

ABIRAMI A K

(Register No- AM20HCD001)

Department of Home Science

St. Teresa's College (Autonomous)

Department of Home Science and Centre for Research

June 2022

DEPARTMENT OF HOME SCIENCE

ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM

CERTIFICATE

This is to certify that the thesis "***Development of Sensory Cards from Banana Stem Fibre for Children with Sensory Issues***" is an authentic record of the research work carried out by Ms. Abirami A K under the guidance of Dr. Dhanya N, Assistant Professor, Department of Home Science, St. Teresa's College (Autonomous), Ernakulam.

Signature of Head of the Department

Signature of Guide

Dr. Dhanya N

M.Sc., M. Phil., Ph. D.,

MA, M. Phil., MBA

Assistant Professor

Department of Home Science

St. Teresa's College Ernakulam

DECLARATION

I hereby declare that the thesis entitled "***Development of Sensory Cards from Banana Stem Fibre for Children with Learning Difficulties***" is a bonafide record of research work done by me during the course of study, under the supervision and guidance of Dr. Dhanya N, Assistant Professor, Department of Home Science, St. Teresa's College (Autonomous) Ernakulam.

Place: Ernakulam ABIRAMI A K

Date:

ACKNOWLEDGEMENT

I take this opportunity to thank God Almighty without whose blessings and guidance this research would not have been completed.

I would like to express my gratitude to all, who have helped me for conducting this research. I extend my gratitude to Rev.Sr.Dr. Celine E, Provincial Superior, CSST and Rev Sr. Emiline, Director, St. Teresa's College (Autonomous), Ernakulam. I also express my gratitude to Dr. Lizzy Mathew, Principal, St. Teresa's College (Autonomous), Ernakulam.

I would like to pay my gratitude to Dr. Susan Cherian, Head of the department of Home Science, for her valuable guidance and support during my thesis work.

I acknowledge my deepest sense of gratitude to my guide Dr. Dhanya N. Assistant Professor, Department of Home science. Thank you for being a constant source of positive regard and encouragement

Special regards to Dr. Elizabeth Suresh, Principal, Rashmika Centre for Special Education Coimbatore for the valuable support extended for my thesis work. My sincere gratitude to Ms. Merlin, Special Educator, Raashmika Centre for special education for helping me in conduct of the survey.

I feel privileged to express my sincere thanks to all my teachers in the Department of Home Science, for their encouragement and support. I also thank all the experts who have evaluated the developed tool and the students who have responded in the survey. I would also like to thank Mr. Chandrabose who have helped me in sourcing the raw materials required for the study. Last but not the least, I thank my parents who remain as strong pillars of support in all my endeavors, they remain as a source of motivation, support and inspiration for life.

- **ABIRAMI A K**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

INTRODUCTION

CHAPTER – 1

INTRODUCTION

The pandemic has resulted in many changes in the educational sector and one of the major change is the shift to virtual mode of teaching. Virtual mode of education has definitely brought the world closer with regard to different educational opportunities, but the effectiveness of this medium is definitely a matter of doubt. While most of the students have adjusted themselves to this medium there are many others who are finding it difficult to fit into this system. The children with learning difficulties and those who are differently abled are the ones who a have major difficulty in adjusting to the online mode of education. Students with the above difficulties completely depend on their teacher's guidance while learning and the impact that a proper teaching environment has on these children is immense which is lacking in the virtual educational setup.

State disability information and resource centre, Bhubaneshwar conducted a study on the impact of digital education on children with disability which has brought out many issues like

- Lack of accessibility to digital devices and internet connectivity
- Network issues and poor connectivity
- Distracting environment at home
- Inability to sustain attention for long hours on electronic devices
- Digital literacy which is lacking in few parents hence they are not being able to guide their children. (Swabhiman, 2020)

Virtual mode of education calls for high level of self-discipline and motivation or else the effort put in by teacher may not have full impact. The extent of involvement of children in the system is also difficult to measure and the level of control that the instructor has on their students is also a matter of doubt. Internet connectivity and access to devices is also an important factor that determines the impact of online learning. Longer durations of screen time are also one of the causes for vision related and other physiological issues which creates an additional burden. The levels peer interaction is also compromised in online mode of education which can lead to feelings of isolation amongst the students. A sharp decline has been observed in the level of subject related

practical exposure in the class. This will negatively impact the academic performance of kinaesthetic leaners as they do not get the sensory stimulations they need to study.

Sensorial learning which is based on the stimulation of the child's five senses is a crucial factor for learning especially for children with learning difficulties and sensory issues. Sensorial learning can help in developing the child's intellect and it helps the child to use his senses to understand what he or she sees. Concepts which are learnt through integration of multiple senses have a greater retention. Sensory activities, in addition to being fun and interesting for young children, encourage children to explore and investigate. Furthermore, these activities support children to use the 'scientific method' of observing, forming a hypothesis, experimenting and making conclusions.

Other reasons why sensory play is beneficial for children include:

- It helps to build nerve connections in the brain
- It encourages the development of motor skills
- It supports language development
- It encourages 'scientific thinking' and problem solving
- It can involve mindful activities which are beneficial for all children

Sensory activities also allow children to refine their thresholds for different sensory information, helping their brain to create stronger connections to sensory information and learn to distinguish which are useful and which can be filtered out. (Good start, 2018). During the pre-pandemic period the classrooms used to be multi sensorial in nature. Activities which cater to the needs of visual, auditory kinesthetic and tactile learners used to be practised but the current online class system is finding it difficult to accommodate the varied types of learners within a class. The virtual mode looks more crowded, bizarre and like a maze to the children with special needs who are not being able to adjust themselves to this system. Children are unable to register the information due to more exposure and faster pace of teaching. Tactile and kinesthetic learners are worst affected by this mode of education and efforts must be taken to develop tools that cater to their needs.

While the concept of integrated education is definitely relevant for children with special needs, depending solely on the virtual mode of teaching is not sufficient. Virtual mode of education has led to an overload of visual stimulations and children are finding it difficult to identify what to focus, filter and absorb. This platform is suitable for the visual and auditory learners but the tactile and kinaesthetic learners are the ones who are affected the most due to lack of sensory stimulation. Sensory stimulation is very important for children because it improves the child's concentration and learning capacity.

The interest toward biodegradable materials as a substitute for petroleum-based incumbents for manufacturing educational materials and toys is growing worldwide. Hence this study aims to use Banana stem fibre based mache as a material for manufacturing sensory cards for children with sensory issues.

Banana fibre, also known as musa fibre is one of the world's strongest natural fibres. Biodegradable, the natural fibre is made from the stem of the banana tree and is incredibly durable. The fibre consists of thick-walled cell tissue, bonded together by natural gums and is mainly composed of cellulose, hemicelluloses and lignin. Banana fibre is similar to natural bamboo fibre, but its spin ability, fineness and tensile strength are said to be better. Over the years the global consumption of banana fruit has quickly outpaced the usage of banana fibres in industrial textile production. On an average, one person consumes approximately 11.9 kgs of bananas per year. But more than a billion tonnes of banana tree stems are thrown away each year, as banana plants only fruit only once in their lifetime before they die. Banana fibre is extensively cultivated in Kerala and the stem is usually discarded. The banana fibre has the potential to be used as a raw material for developing important bio-products such as fibre to make yarn, fabric, apparel as well as fertilizer, fish feed, bio-chemicals, paper, handicrafts, pickles, candy, etc. (Mohiuddin et al., 2014). This banana stem fibre is an excellent material with good tensile strength and varnish treated fibres also have good fire retardant properties. (Kiruthika et al., 2012). The above research suggested that banana stem fibre has the potential to be used as a raw material for developing educational materials as well. Banana stem has been extensively used in textile industries, but the potential of this fibre as a raw material in other sectors is less explored. The objective of this idea is to introduce the concept of sustainable educational material which can be more cost effective and is the best way we can deal with the burden of plastic waste. The most interesting part of this study is the

introduction of the concept of sustainability to children at a very young age and these children will grow up to be citizens who will take care of earth.

The banana stem mache developed in the study serves as the base for the sensory cards. The sensory cards are designed in the form of configuration box and rice bran has been added to the surface of the alphabets in the cards to add more texture. The pre-primary set of words from the Dolch's list was chosen for the purpose of designing the spell cards. It is also an effective method through which banana stem which is constitutes a majority of the agriculture waste in a plantain industry can be sourced to create something beneficial.

Banana cultivation is extensively practiced in Kerala and neighbouring states. Hence the raw material for the product i.e. Banana stem can be sourced from farmers at a lower cost. Setting up manufacturing unit for this product can create employment opportunities for many and sourcing the raw material directly from farmers can serve has an additional income for the farmers. The product can be produced at a low cost and can be a revolution in the field of educational material as it is a sustainable product which is been produced by upcycling an agricultural waste.

Pre-reading which include concepts like oral language, letter knowledge and phonological awareness is one of the skill that children with learning difficulties struggle with hence teaching this concept through sensory cards which are designed in the form of configuration boxes is very useful. Benna spell cards is a product which can help children learn spellings in a fun way. The product has the durability similar to wooden products, provided it is stored in clean and dry environment. The concept of sustainability is growing and this product is way better than plastic alternatives already available in market. It is an open ended educational material and the child can manipulate the product according to their wish to study a wide range of concepts. The educational material designed is useful for kinesthetic as well as visual learners and is a novel approach to introduce sight words to children, hence this product will cater to needs of a large category of children.

Relevance of the study

The pandemic definitely had affected all the sectors which had an impact on human beings and primarily the educational sectors had to undergo several modifications to adjust to the situation. The online mode of education which was adopted as part of this has definitely impacted the student's educational outcome. The inadaptability to this system is very evident through the issues pointed out by the students themselves yet much studies have not been conducted on this circumstance which makes the current study even more important. Students with learning difficulties are the ones who were hard hit due to online education due to the fact that they are majorly kinesthetic and virtual education is not suitable for this type of learners. The present study includes various domains which impact the development of a child, hence it can be inferred that the study effectively identifies the difficulties experienced by students with learning difficulties. The study also brings out a solution to the problem of introducing pre reading skills to children through the development of appropriate tool.

Pre reading skills which are an important aspect for language development can be very difficult to establish through online medium. Hence it is important to have kinesthetic tools which can be used to introduce such skills to children. The study is different from the previous studies done in this field as it emphasizes on the concept of eco friendliness and uses an ecofriendly material as the core material for development of the tool. The developed tool can be used by a wide range of user and it can be produced under low cost as well. The sensory cards developed will be very useful for children who are struggling with pre reading skills.

Aim- The aim of the study was to develop banana stem fibre based sensory cards for children with learning difficulties.

General objective

The general objectives of the study were to

1. Study the effectiveness of virtual education on children with learning difficulties
2. Develop sensory cards suitable for children with sensory issues, learning difficulties and kinesthetic learners.
3. Evaluate the developed tools by experts working in the field.

Specific objective

The specific objectives of the study were to

1. Identify the vision related and mental health difficulties faced by students during online classes
2. Investigate the effectiveness of online education.
3. Develop a tool for introducing pre reading skills
4. Conceptualise an eco-friendly material for developing sensory cards.
5. Evaluate the developed tool

REVIEW OF LITERATURE

CHAPTER -2

REVIEW OF LITERATURE

A literature review is a systematic, explicit and reproducible method of identifying, evaluation and interpreting the existing body of record work produced by scholars. it is a critical summary and assessment of the range of existing materials dealing with the knowledge and understanding in a given field. (Best and Khan, 2011).

The review of literature pertaining to the study "***Development of Sensory Cards from Banana Stem Fibre for Children with Sensory Issues***" is discussed under the following heads:

2.1 The Kinesthetic Approach Towards Learning

2.2 Impact of Screen Time

2.3 Characteristics of Banana Pseudo Stem

2.4 New Innovations in Banana Fibre

2.1The Kinesthetic Approach Towards Learning

An investigation was done on the importance of learning styles in teaching/ learning process. The study suggested that When teachers and students understand how they learn and their preferred ways to learn, the probability for learning increases. The literature also indicates a difference in the learning style types of students in different academic programs.Findings from the data gathered in the study show differences in learning style type based on gender, race, and geographic location. The data also suggests a change in students' learning style type as they progress through their education. This pattern could be interpreted as an adjustment students make in order to accommodate how teachers are teaching. Asstudents move to higher grade levels, one could assume lecture becomes a bigger part of what takes place in the typical classroom. Students may be forced to learn in more auditory ways as a result of the one-way teaching style of teachers. (Csapo and Hayen, 2006).

The study on the effects of visual auditory kinesthetic learning style as technique in improving students' writing ability suggested that The use of VAK learning styles as a technique was effective to improve the students' writing ability. It is proved by the mean score of the students' posttest in the experimental group and control group which were significantly different. Results indicate that The students' interest in experimental group was high to learn English writing by using VAK learning styles. The suggestion made in this research were that in teaching writing descriptive essay, the teacher should be more creative while preparing their teaching writing material. They can use VAK learning styles as a technique to improve the students' writing ability. The teacher should give some enough opportunity and more chance for the students to practice their ability in writing by using VAK learning styles because it is easier to practice and desirable for students. (Litta et.al, 2015).

A research conducted on creating a decision support system for learning disabilities children in detecting visual-auditory-kinesthetic learning style. The DSS is an e-learning system that adapts to learners' preference of learning style automatically, help them identify there learning style and encourage them to learn something that they like. This method is based on the rule base for calculating to estimate each of the student's learning styles based on number of visits and the time that he or she spent on learning objects. This innovative idea can help in eradicating the menace of finding the learning styles through traditional questionnaire method. (Yahya and Noor, 2015).

A study was conducted on Elementary Teacher Perceptions Regarding the Use of Kinesthetic Learning Strategies. Through the reflections of the teachers in this study, it was found that teachers who perceive themselves as successful (confident, comfortable, and willing) and use an alternative strategy, such as a KLP positively, can bring about social change by giving teachers creative freedom to integrate kinesthetic movement into Common Core State Standards. To reach learners of all ability levels, elementary GE teachers who learn strategies to teach the CCSS have a greater chance of aligning teaching practices and student learning outcomes to a greater number of students in elementary education. Teachers could seamlessly incorporate movement into their lesson to improve student engagement and learning without taking away from valuable academic time. Teachers perceived KLPs as useful in teaching the CCSS and experienced support for expanding their teaching practices. Positive social change implications include helping teachers

maximize instructional time and helping students achieve standards and address health needs. (Erikson 2017)

A research was conducted on assessment of prewriting skills for Auditory, Visual, and Kinesthetic Learners preferences. The study emphasizes on making sure that no student is disadvantaged based on a mismatch in teachers' and learners' preferences. Instructors should complete a learning-style preferences survey at the beginning of each course to create a profile of their students' preferred learning styles. Students can reflect on, write about, and discuss their learning style preferences. They can brainstorm learning strategies that they might use to be successful and explore how their cultural or educational background may influence their preferred learning style(s). Moreover, instructors can solicit students' input as to how classroom activities and materials might accommodate their learning styles and take this into consideration when designing activities that meet the course goals. The study ended with the conclusion that the culturally based notion of good teaching no longer needs to be an elusive concept: matching our instruction with our learners' style preferences may be part of the solution. (Leopold, 2012)

2.2 Impact of Screen Time

A research on the impact of screen time and exercise during Covid 19 pandemic suggested that that avoiding excessive screen time and engaging in exercise, particularly outdoors, were important behaviour associated with better perceived mental and general health during the COVID-19 pandemic. Physical activity has always been important for a variety of health outcomes and this study supports the notion that healthy active living is particularly vital during times of confinement to help people maintain their mental and physical health. (Colley et al. 2020)

A study on children's screen time and the complex role of parent and child factors provided new evidence that multiple variables are associated with the amount of time young children spend with media technology each day. While child's age, parent attitudes, and parent screen time influence the amount of time young children spend with technology as individual variables, the way these variables interact is crucial for predicting how much time young children spend with screen media. Few suggestions were also made in this study.Rather than simply recommending that children spend less time with screen media, policymakers should consider the family dynamic

and home environment and creatively develop ways to influence screen media use at a more family-focused level. Since child screen time is highly associated with parent screen time, policymakers should develop strategies that will help parents change their own technology use behaviors or educate parents about the benefits or consequence of various types of technology use in order to influence young children's screen time. (Lauricella et. Al, 2015)

An investigation on Adverse physiological and psychological effects of screen time on children and adolescents indicated that Excessive screen time during childhood and adolescence is likely to habituate the mind to relate more easily to external stimuli, i.e., to lack mindfulness. Hence, internal stimuli such as non-adaptive/negative thinking and feelings of decreased life satisfaction, potentially accompanied by health issues expected in adulthood (e.g., cardiovascular diseases and infertility) may induce a stress hard to cope. Consequently, such coping difficulties, in adulthood, may cause a higher occurrence of depression and anxiety. A sound individual resilience allows a person to face stressful life challenges successfully. Resilience is a dynamic psychophysiological construct which some of its crucial components are compromised due to excessive screen use. Thus, excessive and addictive use of digital media by children and adolescents appears to compromise a development of a sense of positive psychophysiological backbone whichis foundational for the formation of a sound resilience in the nextgeneration. (Lissak,2018)

Study on combined influence of physical activity and screen time and recommendations on childhood overweight considered the simultaneous influence of 2 key risk factors for childhood overweight using established public health recommendations. Children who are not meeting the physical activity or screen time recommendations were 3 to 4 times more likely to be overweight than those complying with both recommendations. Furthermore, those meeting the physical activity and screen time recommendations were the least likely to be overweight.Approximately 10% of the boys and 20% of the girls who metboth guidelines were overweight. In comparison, 35% to 40% of the children who did not meet either recommendation was overweight (Figure). These results demonstrate the utility of these recommendations with regards to childhood overweight. (Laurson et al. 2008).

The study on screen time and metabolic risk factorsamong adolescents examined the association between screen time (ST) (i.e.television/DVD/video and computer use) guidelines and

risk factors for cardiovascular disease, type 2 diabetes mellitus, and fatty liver diseases in mid adolescence. They concluded on the note that. Adolescent boys with ST of 2 or more hours per day on weekdays have twice the risk of abnormal levels of insulin and HOMA-IR compared with peers with ST less than 2 hours per day on weekdays. These results suggest there is an increased risk of insulin resistance among adolescent boys who do not meet ST guidelines on weekdays. (Hardy et.al 2010).

Investigation on Adolescent Screen Time and Attachment to Parents and Peer indicated that screen time was associated with poor attachment to parents and peers in 2 cohorts of adolescents 16 years apart. Given the importance of attachment to parents and peers in adolescent health and development, concern about high levels of screen time among adolescents is warranted. (Richards et.al 2010).

2.3 Characteristics of Banana Pseudo Stem

An analysis was done to find out the chemical composition and the anatomical structure of banana pseudo stem. The technique used were light microscopy, Scanning Electron Microscopy and confocal laser microscopy. Analysis indicated high holocellulose content and low lignin content when compared to non-wood fibre resources. The monomeric content of holocellulose of banana pseudo stem consists mainly of glucose (71.76%) followed by xylose (11.20%) arabinose (7.34%) galactose (2.02%) mannose (0.58%) and galacturonic acid (7.09%). The morphological features where also studied which indicated that the fibre bundles in banana pseudo stem are covered by a non cellulose membrane and are constructed by two kinds of fibres i.e. Elementary and narrow fibres. The narrow fibres resemble pipes rather than fibre bundles (Kun Li, 2010).

A study was conducted on the properties of banana fibre reinforced composites the mechanical properties of alkali treated banana fibre was investigated in this study. The results suggested that the surface modification by alkali treatment has improved the Mechanical properties than untreated fibre composites. The alkali treatment of banana fibre has improved the mechanical properties like tensile, flexural and impact strength of both the epoxy/vinyl ester and hybrid composite. Therefore, it is conclusive from the above result that the alkali treatment has provided better mechanical properties. (Santhosh et.al 2014)

Banana fibre extraction process is low cost effective process chemical treatment improves strength and removes impurities on fibres, chemically treated fibres composite have more tensile properties than untreated fibre composite, chemical composition on banana fibre and BFR composite can be predicted through FT-IR spectrum, scanning electron microscopy reveals surface morphology and factor for failure of composites. BFR effectively composite can be produce by hand layup process.

Evaluation of the primary depithing of banana stem as preprocessing for pulping indicated that bagasse which was produced by processing the stem in a defibrator, and cutting the material in the transversal direction and air dried when considered as a raw material for pulp production has as advantages the facility for handling and digester feeding. The bagasse also shows a high drying rate, what is of fundamental importance for the storage of the bagasse without problems with biological degradation. The possibility of storage of the bagasse is an alternative for overpassing the problems related to the seasonability of the banana stem production. (Soffer et al, 2000)

An investigation was done on utilization of Pectinases for fibre extraction from banana plant's waste. The investigation had been quite useful for solving out the basic problem of improving the quality of machine extracted banana fibre. During fibre extraction from the enzyme treated banana stem and trunk and evaluation of strength of the extracted fibre suggested that an incubation of 36 hours would yield best quality fibre from banana stem. Adoption of the enzymatic route shall help in enabling the handmade paper manufacturers to utilize the machine extracted banana fibre that is available at cheaper price than the hand-extracted banana fibre to produce a good quality handmade paper thereby improving their profitability. (Chauhan and Sharma,2014)

A study on comparison of jute and banana stem composites explores the potentiality of jute &banana fibre composites, emphasizes both mechanical and physical properties and their chemical composition. The study also suggested the utilization and application of the cheaper goods in high performance appliance is possible with the help of this composite technology. Combining the useful properties of two different materials, cheaper manufacturing cost, versatility etc., makes them useful in various fields of engineering, high performance applications such as leisure and sporting goods, shipping industries, Aerospace etc. Hence, with thisback ground, it is concluded that, the composites stand the most wanted technology in the fast growing current trend. The results

suggested that Banana fibre possesses good specific strength properties comparable to those of conventional materials like glass fibres. Banana Material has lower density than glass fibre. Alkali treatments have been proven effective in removing impurities from the fibre, decreasing moisture sorption and enabling mechanical bonding and thereby improving matrix reinforcement interaction. (Pujari et al. 2014).

A research on improving the properties of banana fibre reinforced polymeric composites by treating the fibres provided the following insights- Banana pseudo-stem fibres provide a unique opportunity for reinforcement of thermoplastics such as LDPE. Peroxide and permanganate treatment serve to enhance the interfacial bonding of banana pseudo-stem fibres to their LDPE matrix. Peroxide treatment has the additional effect of enhancing the tensile properties of individual fibres, whereas permanganate treatment has an inconclusive effect on the tensile properties of individual fibres. In terms of composite flexural properties, untreated banana pseudo-stem fibres enhanced the strength and stiffness considerably, with an increasing effect with increasing fibre volume fraction. The permanganate treated composite behaved similarly to the untreated composite, with a slight enhancement in properties compared to the untreated composite at 10% fibre volume fraction and a slight reduction in properties compared to the untreated composite at 20% fibre volume fraction. This may be due to permanganate treated fibres breaking apart as they rub past each other during processing due to their roughened surface. In terms of composite tensile properties, untreated banana pseudo-stem fibres slightly enhanced composite strength and greatly enhanced composite stiffness with an increasing effect with increasing fibre volume fraction. The permanganate treated composite behaved similarly to their untreated composite counterparts at equivalent fibre volume fractions, either matching or slightly underperforming the untreated properties. These trends for the permanganate treated composite do not match the trends shown in other literature, and it may be that in other literature the fibres were alkali pre-treated before the permanganate treatment. In conclusion, banana pseudo-stem fibres provide some measurable enhancement to LDPE properties, especially in terms of tensile stiffness. Permanganate treatment appeared to enhance the interfacial bonding but otherwise appeared to provide little to no advantage over the untreated composite in terms of tensile and flexural properties. This may be due to the permanganate treated fibres not being alkali pre-treated prior to permanganate treatment. (Jorden and Chester, 2017)

Study on effect of fibre surface treatments on the fibre-matrix interaction in banana fibre reinforced polyester composites concluded that Natural fibres like celluloses and their synthetic counterparts often have a surface chemistry that is incompatible for perfect bonding. In order to elucidate the mechanism of interaction on a molecular level, various techniques such as spectroscopy, solvato chromism and zeta potential measurements have been employed. Proper combination of the different techniques is required for a true picture of the interface. Judicious surface modification leads to good interfacial strength and thereby improvement in properties. Chemical modifications have improved the mechanical properties of banana fibre reinforced polyester composites. The highest improvement in properties is found to be for the alkali treated fibre composites. The improvement in properties due to alkali treatment is mainly due the better packing of the cellulose chains, after the dissolution of lignin, which is the cementing material. Silane treatment has also improved the mechanical properties of the composites. Of the various silanes used, silane A151 (vinyl triethoxysilane), has given the highest value. Silane F8261 and Si69 have adversely affected the mechanical properties. (Pothan et al 2002).

Investigation of chemical, thermal and morphological properties of untreated and NaOH treated banana fibre elucidated that The NaOH treatment of the fibres effectively removed the non-cellulosic materials and other impurities from the fibre surface and made the fibre surface smooth. This led to the better fibre matrix interface, fibre bonding and wetting characteristics. The FTIR spectrum also confirmed the NaOH treatment allows the elimination of major parts of lignin and hemicellulose of banana fibres. Also a strong hydrogen bond was noticed on treated fibres, which facilitated better mechanical properties to the fibre. SEM observation revealed the visual evidence that the surface impurities were removed from the fibres on NaOH treatment. It was also visualized that the surface area of the NaOH treated fibres improved and this might lead to better interfacial characteristics of the fibres. NaOH treatment was found to improve the thermal resistance of banana fibres due the removal of the waxy layers and other impurities from the surface. Indeed, the optimal NaOH concentration was reported at 5% in terms of the favoured better to the banana fibres than the raw and, this is mainly due to the reduction of the amorphous parts of the fibres. (Parre et al 2019)

A study on chemically modified banana fibre structure, dielectrical properties and biodegradability observed that by XRD that chemical treatment with NaOH increased the

crystalline fraction of the banana fibre, due to partial removal of the lignin (amorphous phase). The vibrational modes obtained by IR spectroscopy did not suffer significant changes after this alkaline process and the main bands appeared approximately in the same range wave number. The dielectric permittivity and the loss factor are dependent on the alkaline solution concentration. It was obtained 12.59 for dielectric permittivity at 10 Hz with the major concentration. The values for the dielectric loss were approximately between 10-1 and 10-2 depending on the sample. These values are reasonable and could also be utilized as an electronic device in conjunction with other materials to do a composite phase. The dielectric relaxation processes observed by the electrical modulus were dependent on the temperature measurements and related to water molecules present in hydrophilic groups of the anhydroglucose. The chemical treatment employed in this work contributed to increase the metal removal, and the values were governed by solution pH. The results showed that treated banana fibre is a low cost alternative for metal removal in aqueous industry effluents. Thus, for regions with low resources, the biosorbents are an alternative to diminish the impact of the pollution caused by local industries, besides being a biodegradable product. (Barreto et al. 2010).

Research on influence of UV radiation on the physical-chemical and mechanical properties of banana fibre suggested that UV radiation caused changes in the chemical structure and mechanical properties of BFs. Statistical analysis using two-way ANOVA of tensile test, showed that the UV radiation was able to significantly increase the tensile strength of the fibres, when applied in admissible levels. (Benedetto et al.2014).

2.4 New Innovations in Banana Fibre

Banana stem is one of the major agro waste which is produced in India. Having a knowledge about the various banana stem based products is a must to explore the scope of further research in this area. A study conducted usefulness of Banana wastes in Manufacturing of bio-products indicated that the fibre has indicated the banana based fibre is an excellent fibre which can be used to manufacture.

Banana fibre is a natural fibre with high strength, which can be blended easily with cotton fibre or synthetic fibre to produce composite material. In the fibre extraction process, a substantial

amount of lignocellulose wastes is generated, disposal of which creates problem in the adjacent areas. A study was conducted which effectively used this lignocellose to make paper. In the study extracted banana fibre (EBF) and waste banana fibre (WBF) were characterized in terms of chemical and morphological properties to produce handmade paper. WBF was characterized with lower α–cellulose, lignin content and longer fibre length. Pulping of EBF and WBF was carried out with varying active alkali and cooking time at boiling temperature. Pulp yield of WBF was 35.9% after 120 min of cooking with 8% alkali charge. In the unbeaten state the degrees of drainage resistance i.e. SR values were 65 and 71 for EBF and WBF, respectively. The tensile, burst and tear indices of WBF were 23.7 N.m/g, 2.2 kPa.m2/g and 5.0 mN.m2/g, respectively; these were much lower as compared to EBF. The values meet the requirements for handmade paper. (Arafat et.al, 2018)

An investigation into the tensile and morphological properties of banana stem fibre reinforced natural rubber composite was presented. The strength and modulus were found to increase upon reinforcement of the natural rubber with banana fibres. The chemical modification of the banana fibres resulted in yet further improvement in the properties of the composite. The angle of fibre orientation to the loading direction was found to have significant effect on the tensile strength, failure strength and elongation at break of the composites. (Ezema et al 2014)

A study was conducted on mechanical properties study of pseudo-stem banana fibre reinforced epoxy composite which suggested that the tensile strength on the pseudo-stem banana woven fabric reinforced epoxy composite is increased by 90% when compared to virgin epoxy and flexural strength increased when banana woven fabric was used with epoxy material. The results of the impact strength test showed that the pseudo-stem banana fibre improved the impact strength properties of the virgin epoxy material by approximately 40%. Higher impact strength value leads to higher toughness properties of the material. The banana fibre composite exhibits a ductile appearance with minimum plastic deformation. (Maleque et al., 2007).

A literature review study on Banana Fibre Reinforced Polymer Composites suggested the use of banana fibre as reinforcing agent in cement and polymer based composites which was reviewed from the point of view of status, structure, physical, and mechanical properties and different surface treatments of banana fibre based composites. Due to low density, high tensile strength, high tensile modulus, and low elongation at break of banana fibres, composites based on

these fibres have very good potential use in the various sectors like construction, automotive, machinery, etc. As India is one of the largest banana producing countries in the world the use of its fibre and its wastes for producing useful components would be very attractive for the economy. Banana fibre and its composites can be further attractive if a suitable cost-effective design method of fibre separation and its composite production may increase its application to a greater extent. (Narayanan et al, 2010).

A study was conducted to investigate on the possibility of making laminated natural fibre board from banana tree wastes primarily the stem and leaf. The laminated boards produced were made up of banana stem board as the core material and the banana leaf tapes as the skin. The results suggested that Increasing the number of layers of the banana leaf tapes increases the tensile strength, elongation at break, flexural modulus and the impact strength of the laminated boards. The elastic modulus, however, showed the opposite trend. The fibre orientation of the banana leaf tapes has no significant effect of the properties measured. The flexural modulus of the laminated board is related to the tensile strength and thus is not dependent on the viscous component in the board. The impact strength, on the other hand, is dependent on the viscous component in the laminated boards. (Baharin et al.2016)

An assessment was conducted on performance of concrete beams reinforced using banana fibre bars elucidated that the utilization of banana bars in composite and concrete material is a new technique which can be economic, eco-friendly and recyclable. Banana fibre has high cellulosic content. These properties are suitable for its application as building and construction material. The overall goals of this research is to study the influence of the banana bars on the flexure behavior of the RC beams. The flexural strength results from the tested samples showed an increase in flexural strength with increasing fibres content. The flexural strength of beams with banana fibre bars as main reinforcement showed that: Banana fibre bars as a reinforcement for concrete beams give more flexural strength compared to plain concrete by about 25 %. The concrete strength has no effect on the ultimate load and the failure of the concrete beams reinforced using banana fibre bars. (Elbehiry et al.2020).

A research on devising a novel banana fibre pad for menstrual hygiene in India and assessment on its feasibility and acceptabilityindicate that natural fibre based pads are a

feasiblealternative to disposable sanitary products. Pandemic era experiences and fears have temporarily profited reusable menstrual product businesses, but for their long-term survival in the market, rigorous studies need to be conducted. Specifically, repeated cross-sectional surveys and larger studies are required to establish BFP as a safe alternative to manage MHM. The strategy of provision of knowledge and orientation of benefits and trade-off are critical to adoption of environmentally favorable products such as BFP. (Achuthan et al 2021).

An effort was made to development an ecofriendly bio mask from banana stem fibre. The developed mask was first tied to the vacuum cleaner's end, and maximum dust particles accumulated on the mask surface. The same experiment was repeated several times and showed similar results. Furthermore, the experiment was carried out with NaCl; it was found that maximum NaCl was adsorbed on the mask's surface. Few particles were found in the reservoir of the vacuum cleaner. The presence of maximum dust or NaCl on the mask's surface indicates the quality of the filtering efficiency of the mask. (Sen et.al 2021)

A study was conducted on Hybridization of Polyester/Banana stem Fibre and Cow horn particulate composite for possible production of a military helmet. The work has established new reinforcement using Cow Horn particles and Banana Stem Fibre for the production of polyester composite for possible use in the production of a military helmet. The conclusions of the study were that the new composite of polyester using CHp and BSF as reinforcement was successfully produced. Lower weight helmet that will not be too heavy and the same protect the safety of the personnel can be produced from this formulation. A 94.66% enhancement in tensile strength and 174.79% of the impact energy were obtained. The values of the impact energy, hardness values, strength and ballistic resistance obtained in this work are within the range for the production of military helmet. (Abdulrahim et al. 2021).

An attempt was made to develop a novel suture biomaterial from the pseudo stem of bananas which is an agricultural byproduct. Furthermore, the suture was functionalized with an AV-GA based hydrogel containing antimicrobial agents and growth factors. The surface modified suture possesses excellent tensile strength along with the desirable physico-chemical properties of an ideal suture. The fabricated suture was found to be biocompatible and also exhibited the sustained release of drugs for up to 144 h. The banana stem suture exhibited a significant

antimicrobial activity against infectious microbes such as S. aureus, E. coli, and C. albicans in both in vitro and in vivo conditions. Furthermore, the banana stem sutured animals showed pronounced wound healing through the reduction of infection and related inflammatory markers at the wound site. The study concluded that the material has a potential to be used as a suture material. (Kalita et al 2018).

A study was conducted on utilization of banana fibre composites for automotive and transportation applications, the study brought out the following results The flexural strength of banana fibre/eco-polyester composites is 40.16 MPa, which is 14.78% higher than the strength of banana fibre/epoxy. The higher flexural strength and modulus observed in the banana fibre/eco-polyester composites is related to improved fibre/matrix interaction. Compressive properties were also found to be dependent upon the fibre/matrix interactions, which improve with alkaline pretreatment for an epoxy matrix and degraded with such treatment in the eco-polyester matrix. Thus, the highest compressive strength of 122.11 MPa of the banana fibre/epoxy composite is attained after fibre pretreatment and is 38.35% higher than the observed strength without the treatment. On the contrary the highest compressive strength in banana fibre/eco-polyester composites is 122.88MPa and is achieved without fibre pretreatment; the use of alkaline substances yields 31.07% lower properties. Water absorption is also dependent upon the fibre/matrix interactions but with the additional factor of increased water absorption by the biobased resin; therefore, moisture absorption is higher for eco-polyester matrix composites. It was observed that environmental resistance is higher in banana fibre/epoxy composites with alkaline pretreatment, followed for banana fibre/polyester composites without any treatment. This is due to improvement in fibre/matrix interaction with the fibre chemical pretreatment in epoxy composites and to deterioration of the interphase in polyester composites. (Estrada et al, 2015).

An experimental investigation on the mechanical properties of concrete mixed with banana stem fibre as well as hybrid steel fibre concluded that the presence of both banana stem and steel fibre in concrete, the compressive, tensile and flexural strength found to be optimum at 1 % volume fraction of fibre. It was observed that beyond 1% volume fraction of fibre content in concrete there is a gradual decrease in compressive, tensile and flexural strength. The impact strength of both type concrete observed to be increased as the percentage of banana stem fibres and steel fibres are increased and also steel reinforced fibre concrete having more impact strength than banana stem

fibre concrete. Based on this result, it was concluded that the addition of both banana stem fibre and steel fibre emphasizes the basic physical properties of concrete. (Chandar et.al 2018)

Study on influence of fibre volume and fibre length on thermal and flexural properties of a hybrid natural polymer composite prepared with banana stem, pineapple leaf, and s-glass suggested that increment in the fibre volume and fibre length induces the enhancement in the flexural and thermal characteristics of the hybrid composites. After reaching 40% of the fibre volume, the mentioned characteristics started to decline. Hybrid Taguchi GRA techniques suggested that PALF-reinforced S-glass fibre with a 40% fibre volume and 40 cm fibre length provides the optimum mechanical and thermal properties compared to other combinations. (Prakash et. Al 2021).

A study on design and manufacture of skateboard from banana stem concluded that static testing of polymer composite board specimens from banana stems obtained the average value data for the composition of 5% banana stems is 9.81 MPa, for the composition of 10% banana stems an average of 13.60 MPa, and composition of 15% banana stems the average is 27.20 MPa. The analysis shows that the best composition is 15% of banana stems, with an average flexural strength value of 27.20 MPa. Therefore, the composition used in this study is the composition of 15% reinforcement of banana stems which is considered to be the ideal one. (Zulfikar et.al,2019).

A research on utilization of banana fibre-reinforced hybridcomposites in the sports industry suggested that a hybrid polymer matrix composite with the reinforcement of banana fibre could withstand higher loads and stresses as compared to pure glass fibre reinforced composites. G7B1 composite can withstand higher loads as compared to the G8 composite, while G6B2 composite shows relatively lower strength with respect to the G8 composite. The possible reason for G7B1 results showing higher flexural strength than G8 is a strong bonding between the plies. Increasing the number of banana-fibre layers reduces the strength of the material. As banana fibre has poor properties compared to glass fibre such as uniformity, hydrophilic phenomenon, and strength, it can only be used in hybrid composites at a certain optimized weight percentage, such that adding more layers of banana fibres drastically decreases the mechanical properties. Although there is a limitation to the application of natural fibres, further research should be carried out to enhance their applicability in industrial products. From the experimental results, we observed that the addition of banana fibre in the polymer matrix resulted in brittleness of the material. It is

recommended to add coir fibre along with banana fibre to enhance the ductility of the material where brittleness is not desired. It can be concluded from the numerical simulation that FEA tools can correctly predict the mechanical behavior of the composite materials and can be used to analyze innovative materials further. Newly designed materials could be a replacement for synthetic fibres conventionally used in field hockey equipment production due to the considerable economic and environmental benefits. Further studies can be performed to analyze such innovative and green materials toimprove the mechanical properties of natural fibres to replace synthetic materials with eco-friendly materials completely. (Rashid et al. 2020)

Research on thermal and mechanical characterization of banana fibre reinforced composites for its application in injection molding presents the thermal and mechanical characterization of thermoplastic composite polymers reinforced with banana fibre. ABS, HIPS, and HDPE were used as matrices, reinforced with different percentages of banana fibre to analyze their behavior in injection molding processes. The different thermal tests carried out showed a thermal behavior of the composites similar to the matrices, without great changes in the different thermal transitions, although with an expected reduction in the MFI. Neither was a worsening in the degradability observed. Therefore, from a thermal point of view, the use of banana fibre as reinforcement in composites for its conformation through injection molding processes is viable. As for the mechanical characteristics, the composites showed in all cases an increase in the elastic modulus with the increase of banana fibre content, indicating that reinforcement allows more rigid materials. This increase in stiffness was also confirmed with the impact tests, where a decrease in the energy absorption was observed with the increase of banana fibre content. On the other hand, the maximum stresses remained practically unchanged in the tensile test (except in HIPS composites), while in the flexural tests were higher with the increase of banana fibre content (except for the ABS matrix composites). These results show some variability in the fibre–matrix interaction depending on the type of matrix used, being more efficient in HIPS and HDPE than in ABS. Therefore, the use of banana fibre can be especially promising as a natural reinforcement in the production of parts subjected to bending loads, which is one of the most common load cases. However, it is important to note that the effects produced by the reinforcement can vary depending on the matrix used, and especially in the quality and uniformity of the fibre used. (Kusic et al. 2020).

Study on mechanical properties of short banana fibre reinforced natural rubber composites indicated that as the fibre concentrations increases tensile strength also increased. When fibre concentrations are less the matrix and fibre interface shows weak bonding. The incorporation of fibre into rubber matrix increases the hardness of the composite, which is related to strength and toughness. The close packing of fibres in the compounds increases the density while resilience decreases. The composites made from 15mm length banana fibres shows the maximum tensile strength and good tear strength. Natural rubber can successfully be used as matrix in bio composites. Using different surface modifications of fibre, the strength of the composites can be increased. (Raghavendra et al.2013).

A study was conducted on properties of banana fibre reinforced green composite result indicated that the structural characteristics of natural fibre composite together with its excellent environmental attributes show its potential as a construction material. The results show that composites with multilayer model have higher modulus than those without layer model composite preparation. This indicates that the multilayer model has resulted in the increased polymer–natural fibre interaction site. They are very well suitable for wall and roof construction. In the present scenario as the environment is degrading and the demand for energy are raising the composites utilizing naturally available fibres provide alternatives to save the environment and diminish energy consumption, which could be needed to process human-made synthetic composites. But, further research and development is required for the extraction and characterization of the basic materials such as fibres to avoid any setback during the transition, i.e. for upscaling of technology from lab scale to the commercial level. (Sharma and Kumar 2013).

Research on influence of alkaline modification on selected properties of banana fibre developed paper bricksby the incorporation of modified and alkaline (1 M NaOH) modified banana fibre and fine sand into cement-paper-sand mix and the samples produced were examined and reported. The following conclusions were observed in this study, water absorption increased slightly with banana fibre loading, howbeit samples infused with modified fibres absorbed lesser water volume than the unmodified ones. Moisture absorption increased with rising UMBF dosage while consecutive addition of AMBF resulted in a decrease in moisture assimilation mechanical strengths were boasted with fibre inclusion even as the modified fibres presented higher enhancement. Curing duration also participated effectively in strength enhancement. Alkaline

modification and curing were noted to be effective in improving the properties and performance of paper bricks, and therefore recommended for property optimization in paper bricks. (Akinwande et.al 2020).

METHODOLOGY

CHAPTER- 3

METHODOLOGY

Methodology refers to the systematic protocol that is adopted to study a problem. The present study entitled "***Development of Sensory Cards from Banana Stem Fibre for Children with Sensory Issues***" is described under the following subheads

3.1 Selection of Area

3.2 Selection of Sample

3.3 Selection of Tool

- 3.3.1 Development of questionnaire
- 3.3.2 Development of banana fibre based spell cards
- 3.3.3 Development of opinionnaire

3.4 Data Collection

- 3.4.1 Survey on effectiveness of virtual education for children with learning difficulties
- 3.4.2 Evaluation of banana fibre sensory cards

3.5 Analysis and Interpretation

3.1 Selection of Area

The study on effectiveness of virtual education for children with learning difficulties was conducted in Rashmika school for special education. It is a centre that caters to children with learning difficulties, slow learning and attention deficit hyperactivity disorder. The centre actively trains its students to enable them to join mainstream or are supported to take 10^{th} board of exam either through state board or NIOS. Support for conduct of the study was extended by the principal and the faculty members of this institution. The institution encouraged training activities and implementation of novel ideas in the field special education within their system, which made the institute the preferred area for conduct of the study. The expert evaluation of the banana stem fibre sensory cards was conducted by experts working in the field of special education. The experts were

from Assisi vidyaniketan public school thrikakkara, Adarsh special school Tripunithura, Raksha special school mattancherry, Cottolengo special school fort kochi.

3.2 Selection of The Sample

Children with learning difficulties were the prime sample for the study. A total of 21 children were selected from Rashmika School for special education, Coimbatore. The school had adopted virtual mode of education till March 2022 which makes the sample group to be the apt ones for responding to the questionnaire on analysis. Respondents were selected from both rural and urban area using purposive sampling.

A group of 23 experts were selected for evaluation of the tool. The experts were teachers who were working in the field of special education and have been addressing the needs of children with learning difficulties. The experts were from Assisi vidyaniketan public school thrikakkara, Adarsh special school Tripunithura, Raksha special school mattancherry, Cottolengo special school fort kochi and were selected using purposive sampling.

The sampling for the study were students who were undergoing special education and the experts were teachers who are working in the field of special education and they were selected on basis of the researcher's discretion hence it can be inferred that purposive sampling was used in the study. Purposive sampling, also known as judgmental, selective, or subjective sampling, is a form of non-probability sampling in which researchers rely on their own judgment when choosing members of the population to participate in their surveys. (Alcheimer,2021).

3.3 Selection of Tool

Three tools have been used in this study. The first tool selected was a self-formulated questionnaire which evaluated the effectiveness of virtual education for children with learning difficulties. The tool consisted of 41 questions. It consisted of various aspects like general details, area of residence, distractions during online class, vision related issues and mental health of students. The questions were formulated in simple language with close ended questions to suit to the ease of the respondents. The results of the survey indicated a lack of kinesthetic tools which led to the

formulation of banana stem fibre based spell cards. The spell cards were evaluated on account of a self-structured opinionnaire which served as the third tool used in the study.

3.3.1 Development of questionnaire

The impact of online classes especially on the students with learning difficulties is an area which is has not been explored much. Hence as part of the study a questionnaire was prepared which included the emotional and vision related aspects of a student which regard to virtual education. The vision related aspects included factors like incidents of eye strain, vision defects, physical activities etc. The emotional aspects included feelings of isolation, missing friends and various other stress inducing factors. The questionnaire covered multiple domains and could bring out the extent of the effectiveness of this system. A copy of the same questionnaire has been given in the Appendix- I.

3.3.2 Development of banana fibre sensory cards

The survey indicated that there was a potential for kinesthetic tools to introduce pre reading skills to children who had learning difficulties. As a result, the banana fibre sensory cards were developed which served as an eco-friendly alternative to introduce pre reading skills to children. The banana stem mache which was used to make the sensory cards had banana fibre and maida based binding material as its core ingredients. The alphabets in the sensory cards were given extra texture by incorporating rice bran into it. The vowels and consonants were also colour coded in red and blue so that this concept can be also introduced to the children. The sensory cards were designed in the form of configuration boxes to help the child understand the orientation of individual alphabets better. Separate cards were included for alphabets so that children can gradually learn proceeding from alphabets to words. General description of the product as well as usage manual were included to aid in ease of use.

3.3.2 Development of opinionnaire

A self-prepared opinionnaire was prepared for evaluation of the banana fibre sensory cards. Ten factors which are critical for study material like accessibility, interest generation, adequacy, eco-friendliness, adequacy etc. was included and a scoring between 1 to 5 was used for evaluation of the material. A copy of the same questionnaire has been given in the appendix 2.

3.5 Data Collection

The data collection was done in 2 phases.

3.5.1 Survey on effectiveness of virtual education for children with learning difficulties

The questionnaire on effectiveness of virtual education was sent to the institution, which was further distributed to the students in printed format. The teachers were sensitized regarding the different elements of the survey, and this enabled them to clarify the students queries during sampling. The collected data was then received through mail and was further tabulated.

3.5.2 Evaluation of banana fibre sensory cards

The prepared opinionnaire with regard to the spell cards was used for evaluation of the banana fibre sensory cards. The evaluation was conducted by23 experts from top special schools in Ernakulam district of Kerala. The tool was presented to the evaluators alongside the opinionnaire and their judgements were recorded systematically.

3.6 Data analysis and interpretation

The results of the survey on efficiency of virtual education for children with special needs using the questionnaire were consolidated and presented in the form of table and pie charts Percentage analysis was used to identify the severity of various factors. The survey was used to compare the efficiency of virtual education amongst children with learning difficulties. the sample included both boys and girls and students from urban and rural areas. The opinionnaire for spell cards that consisted of 10 factors the mean scores for each category was tabulated and the inferences are presented in next session.

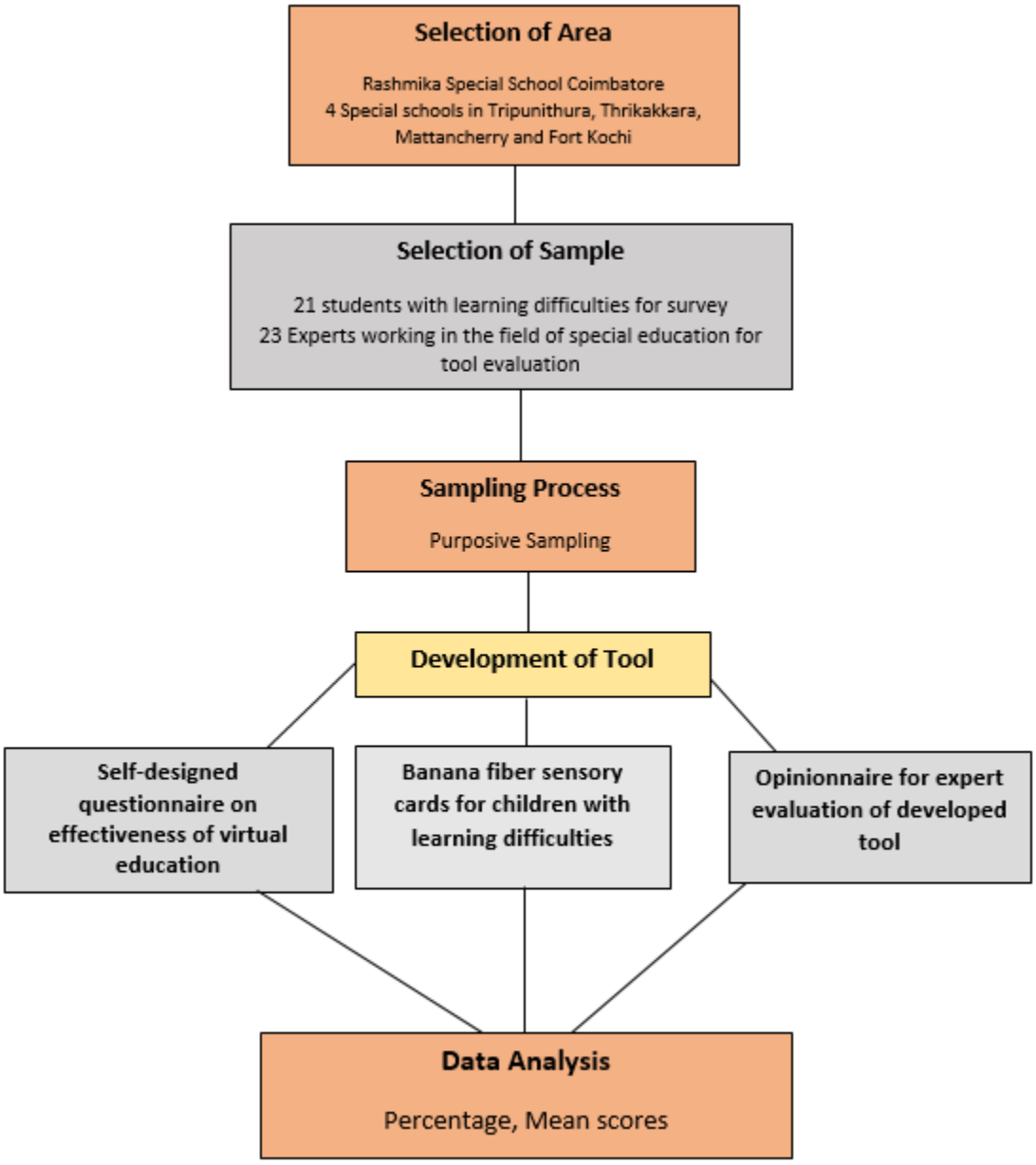

Figure 1

Research Design

RESULTS AND DISCUSSION

CHAPTER - 4

RESULTS AND DISCUSSION

The results of the study entitled "***Development of Sensory Cards from Banana Stem Fibre for Children with Sensory Issues***" was systematically complied and presented under the following headings.

4.1 Survey on Effectiveness of Virtual Education for Children with Learning Difficulties

- 4.1.1 Background details of the selected sample
- 4.1.2 Study environment at home
- 4.1.3 Assistance from teachers during online classes
- 4.1.4 Attention span of students during online class
- 4.1.5 Types of learners and Academic pressure during online class
- 4.1.6 Functioning and Major issues in online class
- 4.1.7 Emotional and Vision related difficulties experienced by children
- 4.1.8 Effectiveness and involvement of the students

4.2 Development of Sensory Cards from Banana Stem Fibre for Children with Sensory Issues.

- 4.2.1 Processing of banana fibre
- 4.2.2 Preparation of maida based binding material
- 4.2.3 Preparation of the banana fibre mache
- 4.2.4 Preparation of spell cards

4.3 Evaluation of Tool

- 4.3.1 Expert evaluation of banana fibre sensory cards
- 4.3.2 Presentation of the tool at Kerala start up mission expo

4.1.1 Background details of selected students with learning difficulties

The details of selected students from is represented in table 1.

Table 1

General information of Respondents

Sl No	Particulars	Responses (N = 21)%
1.	Age in years	
	• 7 years	35
	• 12 years	5
	• 13 years	14
	• 14 years	31
	• 16 years	15
2.	Class	
	• 2 nd Standard	35
	• 6 th Standard	20
	• 8 th Standard	31
	• 9 th Standard	14
3.	Area of Residence	
	• Urban	81
	• Rural	19
4.	No. of Siblings	
	• Nil	29
	• One	71

Basic details of the respondents were collected which included criteria like age, class, area of residence, no of siblings, details regarding parental occupation and the educational qualifications of their parents. The respondents were from the age group of 7 to 16 years. It seen from the above table that 35 per cent of the respondents were from the age group of 7 years, 31 percent w from the age group of 14 years, 15 percent of the respondents were 16 years old and 14 per cent of the respondents were 13 years old. Corresponding to their age 35 per cent were studying in 2nd

standard. Around 81 per cent of the respondents were from urban are and most of them (71%) had one sibling each.

4.1.2 Study environment at home

The study environment at home was analysed in the study. The occurrence of distraction within students during online class and the various distracting factors have been presented in Fig 2 and Table 2 respectively.

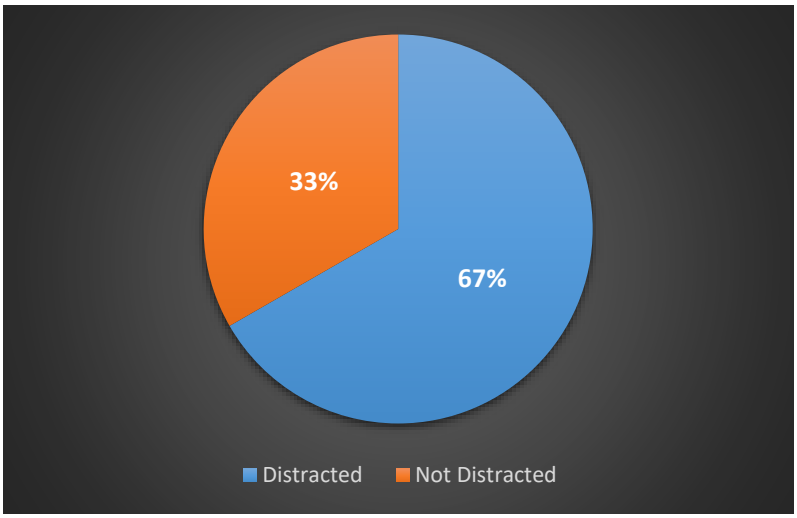

Fig 2- Incidence of distraction

Table 2

Major sources of distraction

Sl No.	Major Sources of Distraction	Responses (N = 21)%
1.	External Sounds	91
2.	Too much visual input	10
3.	Curiosity to Explore	10
4.	Chatting in between	5

An evaluation was done on the major sources of distractions and the respondents were given the freedom to choose multiple options. Out the selected sample, 67 per cent reported that they were distracted during online classes. The major source of distraction included external sounds which accounted for 91 per cent followed by excessive visual input (14%), Curiosity to explore (9%) and chatting in between was reported to be five per cent. The results indicate that it is very important to set a conducive study environment at home. Learning through virtual media can be very difficult if there are many distracting factors in the environment. Conscious efforts can be made from parents to lessen external sounds so that the child does not lose focus. Which regard to other distracting factors the students much be trained to improve self-discipline so that they do not wander around during online classes.

4.1.3 Assistance from teachers during online classes

The frequency of assistance that was provided by the teachers to their students has been presented in Fig-3.

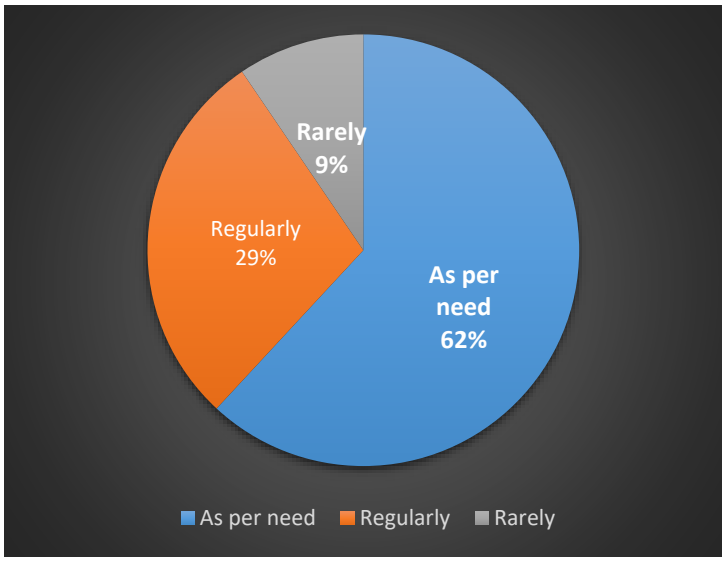

Fig 3- Discussion with teachers

It is evident from the above figure that 91 percent utilised online classes to clear their doubts. With regard to discussion with teachers, 62 per cent responded that they interact with teachers as per their need, 29 per cent of the students had a regular interaction with their teachers and nine per

cent rarely interacted with their teachers. It can be inferred from the results that there has been a decline in casual interaction between teachers and students in the online platform.

Students especially with learning difficulties depended intensively upon their teachers for academic and personal support. The key to effective learning is the interaction and the relation between the teacher and student. Virtual education has lessened the opportunities for physical interaction between students and their teachers but individual attention must be given to students, so that they remain motivated. This can be done through regular one to one meetings and having a casual talk session at the end of every class, where the students are allowed to discuss casual matter happening in their life.

A similar study was performed to understand the teacher's perception to online teaching in high school sector in Russia. The analysis of the participants' answers helped to identify the following main challenges experienced by university teachers: computer literacy level, the university electronic environment and support, academic staff readiness and students' readiness for online learning, the last two being the most important hindering the implementation of the efficient online education process. It was also underlined by most respondents that methodological work of a teacher in a digital educational environment differs from conventional teaching methods (Almazova et al 2020). This study correlates with the present factors that the effective training and making online media to be user friendly is a must and technological support must be provided to both teachers and students.

4.1.4 Attention span of students during online class

The figure given below represent the attention span of selected students during online classes.

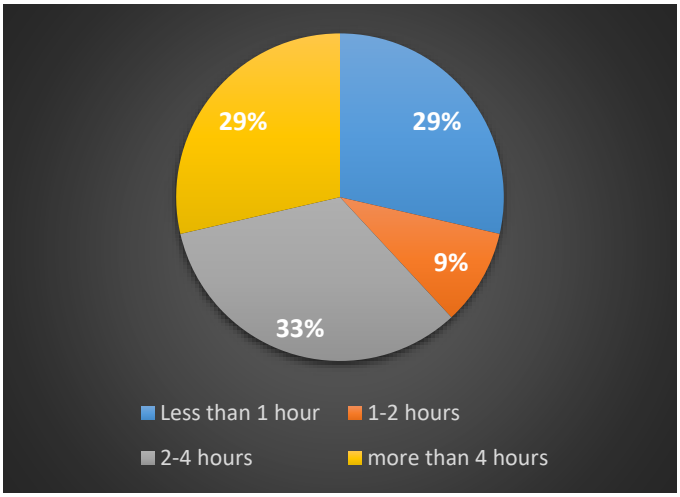

Fig – 4 Attention span during online class

Students were asked about the time period for which they can sustain their attention during online class. Thirty-three per cent responded that they could sustain their attention for 2- 4 hours, 29 per cent of students had an attention span between 1- 2 hours and another 29 per cent could sustain their attention for more than 4 hours. Nine per cent of students indicated that they could hold their attention only for a period of less than 1 hour.

Being focused during class is an integral factor that contributes towards academic excellence. Majority of the students responded that they can sustain their attention between 2 to 4 hours. This indicated that if the students are forced to attend classes which exceed this duration it may lead to inattention on part of the students. Proper schedules must be made so that the children are provided which adequate breaks and they are not forced to attention long classes.

4.1.5 Types of learners and academic pressure during online class

The sections details on the types of learners and academic pressure experienced by students during online class, the gathered information regarding the same as been represented in Table 3, Fig 5 and Table 4 respectively.

Table 3

Learning pattern of respondents

Sl No.	Learning style	Responses (N = 21)%
1.	Tactile	33
2.	Visual	33
3.	Kinesthetic	19
4.	Auditory	14

An analysis was done on the learning style of the respondents. Thirty-three per cent children responded that they learnt better when by writing notes, similarly 33 per cent learned better when the topics were presented visually, 19 per cent could understand the concept through hands on activities and fourteen per cent learnt well when someone explained the topic to them. Every class has a mixture of the four types of leaners and few students were also found to have a mixture of different learning styles within themselves. Hence care must be taken so that the classes are conducted in a manner which accommodated all the types of leaners. A mismatch between the learning style and teaching style can lead to poor academic outcome. The diverse types of learners indicate that online learning which is more accommodating to auditory and visual learners may not cater to the needs of tactile and kinesthetic learners. Hence practical activities that can be done within the student's home should be included in the syllabus. Regular monitoring must be also undertaken, so that the teachers can give students necessary guidance and suggestions if necessary. The system of recorded classes can be also employed so that the auditory learners can listen to the lectures for better understanding.

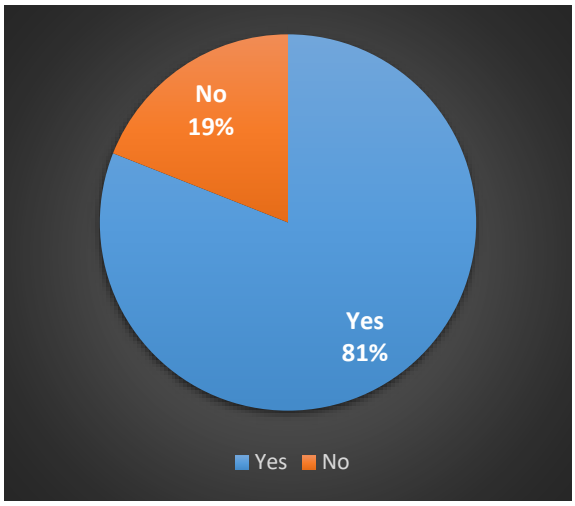

Fig 5 - Incidence of Academic pressure

Table 4

Parameters of academic stress

Sl. No	Parameters for academic stress	Responses (N = 21)%	
		Present	Absent
1.	Break during classes	91	9
2.	Effective Feedback system	86	14
3.	Completion of syllabus	86	14
4.	Completion of tasks	66	24
5.	Equal attention by teachers	52	48

The results indicate that 81 per cent of the respondents believed that academic pressure has increased during online classes. Sixty-six per cent of the respondents reported that they were able to complete the tasks given by their teachers and 52 per cent responded that teachers are able to give equal attention to all the students in the class. The results suggest that the majority of the students (91%) were given breaks during class this can be an effective way to ease stress for children who have difficulty to maintain attention. Effective feedback system helps in regular monitoring of the students works and aids in academic progress. The syllabus is also being completed on time so that the children are not stresses during their study period. A major fault that

was identified is that the teachers are not being able to give equal attention, those students who are being attended will excel with regard to academics and those who do not get attention may get distracted and will not focus on their academics.

A similar study was conducted to understand the perceptions of academic stress and the coping strategies adopted to tackle the stress. The results suggested that students were experiencing stress arising out of many academic as well as non-academic aspects such as environmental, socio-cultural and psychological factors. Stress arises in a way to perform better than peers, to live up to the expectations of parents, teachers, to score better grades which will help to get a dream job. All these put heavy pressure on students leading to a feeling of burnout arising from academic stress. The findings indicated significant differences were observed between the fear of academic failure and online and home environment among male and female students. Many of them have started diverting themselves to various creative activities and taking up courses that are helping them to learn new technical skills. By using emotional intelligence and distancing from boredom and depressive thoughts, students were trying to cope with negative effects arising from the pandemic situation. (Chandra,2020)

4.1.6 Functioning and major issues in online class

The preferences for exam and learning material and the attendance of the sample of selected children are represented in Table 5 and Fig 6 respectively. The major issues faced by students during online classes and the evaluation on physical activity and practical experience have been depicted in Fig 7.

Table 5

Preference for learning material

Sl No.	Preferences for exam and learning material	Responses (N = 21)%	
		Online	Offline
1.	Exam	19	81
2.	Learning material	38	62

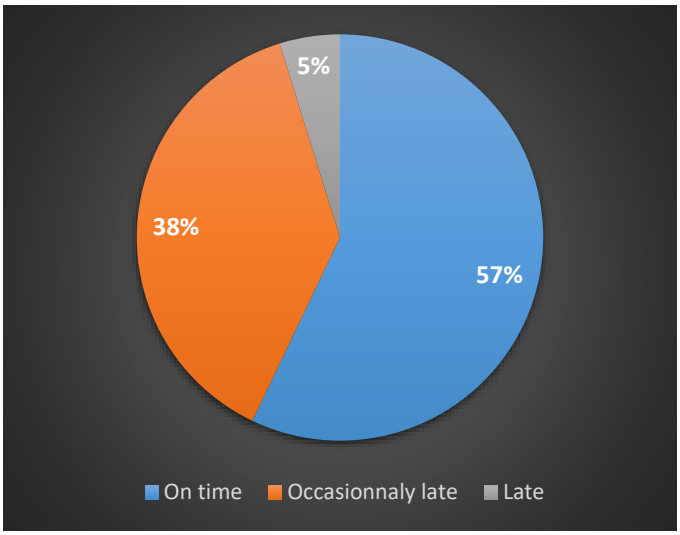

Fig 6 Attendance of students

An analysis was done on the preferred medium for examination and learning material which indicate that 81 per cent preferred offline mode of examination and 62 per cent opted for offline learning materials. The preference for offline learning material indicated the inability to adjust to online of examination and learning. The various factors which make online learning difficult like distraction, incongruence to learning style, physiological and psychological factors could be the reason for this. The attendance of students during online class was also studied which indicated that almost 57 per cent of the students joined on time, 38 per cent were occasionally late and five per cent of the students were always late to join the classes. This indicates that the class schedule is being implemented strictly and the children are also aware about the importance of joining class on time. Proper attendance in class also indicates that the children are not missing the lectures completed in classes.

A study on overview of attendance and participation in online class during the covid pandemic indicated that, online learning was a key factor during the Covid-19 lockdown to keep teaching and learning activities continuing. It was not easy for students and teachers to cope with online learning as they identify restrictions and challenges to handle them. However, the students had better class attendance in online system when compared to the conventional class system. Results also suggested that the general preference is for offline classes yet students were appreciable regarding the structure of the online study system. (Qutishat et al. 2022).

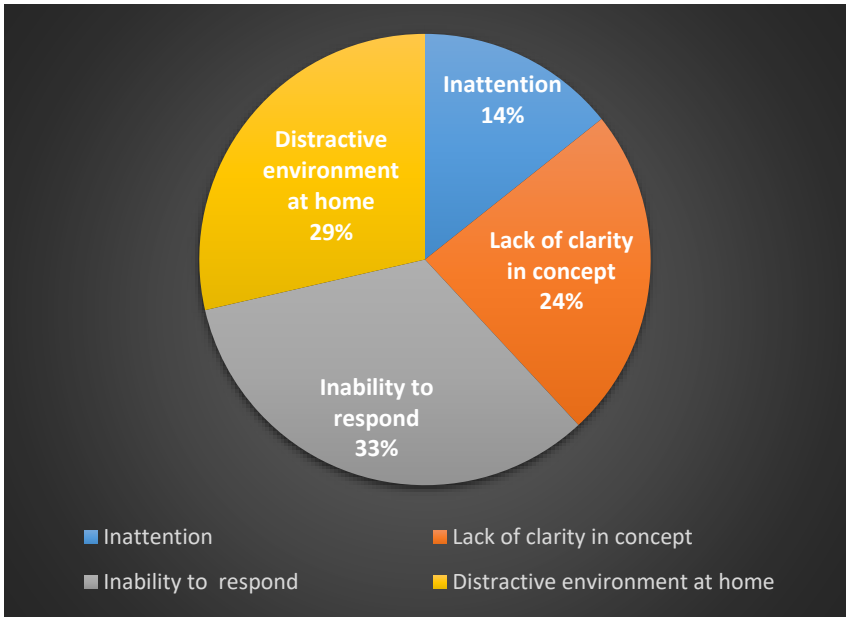

Fig 7 - Major issues in online learning

Table 6

Evaluation on physical activity and practical experience

Sl No.	Issues	Responses (N = 21)%	
		Agree	Disagree
1.	Lack of physical activity	62%	38%
2.	Lack of practical experience	76%	24%

An effort was made to identify the major issues during online classes thirty three per cent responded that they were unable to respond during classes, 29 per cent said that they had a distractive environment at home while 24 per cent opted that there was a lack of clarity in the concepts. Inattention was the major cause of concern for 14 per cent of the respondents. Seventy per cent experienced lack of physical activity and 66 percent experienced a lack of practical

experiences due to online mode of education. The present of such a diverse range of distractions indicate that changes have to be brought in the system to minimize such limiting factors. Delivering practical classes through virtual medium might not be possible but efforts can be made to exposure the children to possible activities and making it as close to the practical experience.

A similar study was conducted on teaching practical courses to children through online medium, the results indicated that the majority of the teachers and students were afraid of missing the practical skills during the crisis because these skills could not be compensated by e-learning techniques. However, they preferred live teaching and recording of the practical courses. The solutions have been developing but may resort to moving many practical sessions online, creating virtual cases, engaging the students with telemedicine environments and simulation modes. (Elhathy et al 2020)

4.1.7 Emotional and vision related difficulties experienced by children

Fig- 8 and Fig 9 represents the opportunity for peer interaction amongst the selected student sample and the feelings of isolation amongst students during online class respectively. Fig 10 represent vision related issues faced by students

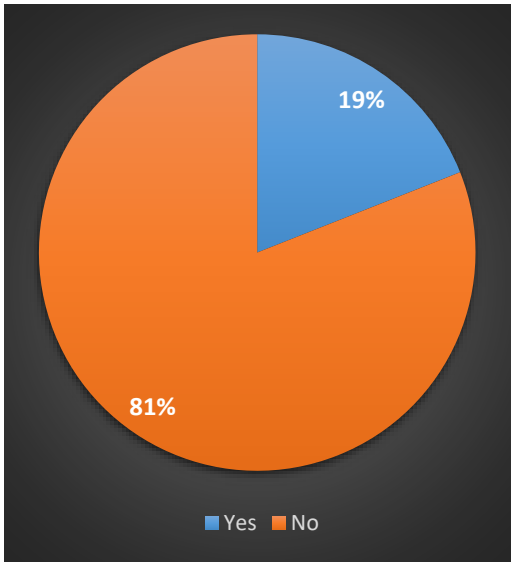

Fig 8- Opportunities for peer interaction

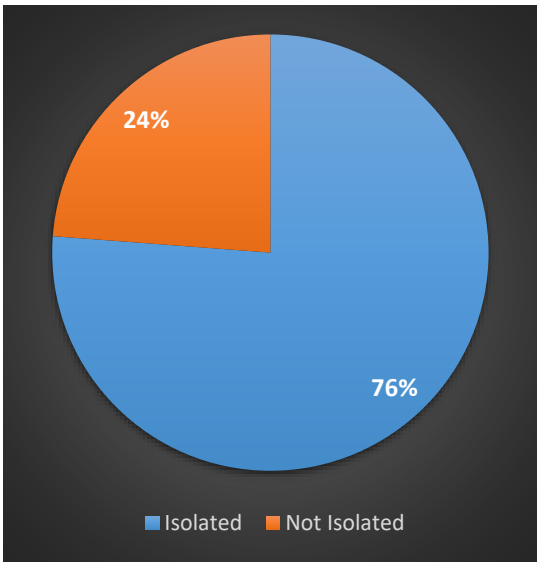

Fig 9- Feelings of isolation among students

Peer interaction is one of the major factors that aids in the social development of an individual on enquiring the students on opportunity for peer interaction 81 per cent responded that they do not get an opportunity for peer interaction and 76 per cent had developed feelings of isolation during the pandemic period. These factors indicate that the lack of social interactions had adversely affected the mental health status of the students. Pandemic has definitely taken a toll on the mental health of everyone irrespective of gender and age group and the lack of fruitful interaction is a major contributing factor to this. Group activities which can be completed through online medium can be given which will improve the relations and promote conversations between students.

A study on mental health status of children and adolescents in China during covid 19 outbreak indicated similar results, that the COVID-19 outbreak has had a significant psychosocial impact on children and adolescents. Findings indicated an increase in incidents of anxiety and depression highlight the need to address emotional distress for children and adolescents during the epidemic and also provide researchers with scientific fundamentals to formulate targeted interventions based on the significant influencing factors. (Duan et al 2020)

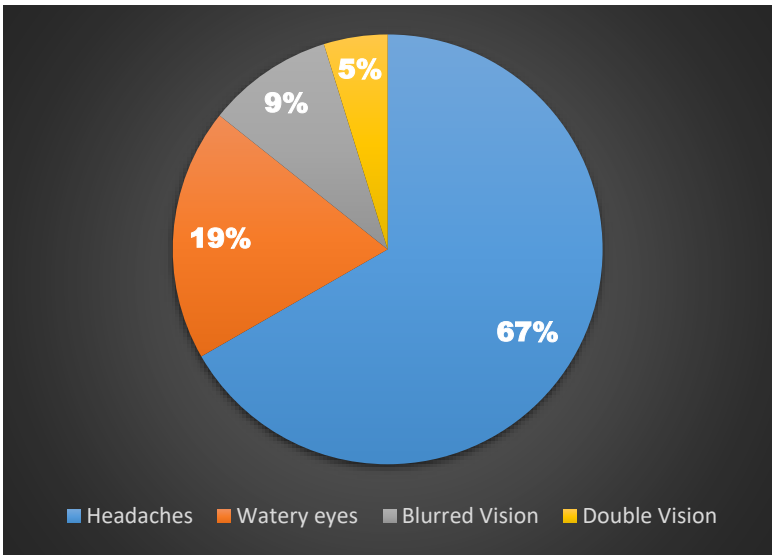

Fig 10 - Vision related issues during online class

Eighty-six per cent responded that they experience eye strains during online classes. On enquiring regarding the type of difficulty (67%) experienced headaches, (19%) had watery eyes, (9%) experienced blurred vision and (5 %) developed double vision. The above vision related problems can be an indication of increased screen time due to online mode of education. Strict regulations must be kept to reduce over screen time and parents can also regulate their children's screen time for casual browsing. Serious physiological difficulties must be given due attention so that the health condition of the child do not worsen.

4.1.8 Effectiveness and involvement of the students

The effectiveness and involvement of students during online classes has been presented in Fig-11 and Table 7 respectively.

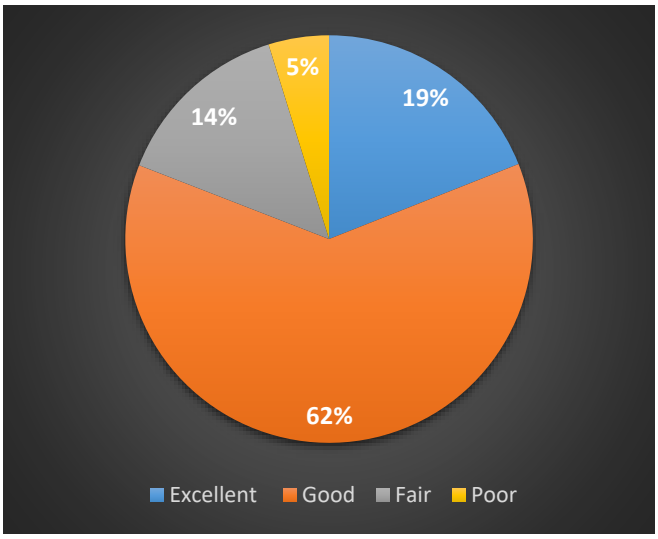

Fig 11 - Involvement in online classes

Table 7

Effectiveness of online classes

Effectiveness of online classes	**Responses (N = 21)%**
Very effective	19
Moderately effective	67
Ineffective	14

Eighty-five per cent of the students preferred offline education, 10 per cent preferred online mode of education and five per cent preferred hybrid mode of education. With regard to involvement in class, 32 per cent rated their involvement as good, 19 per cent as excellent, 14 per cent as fair and 10 per cent had poor involvement during class. Online mode of education was very effective for 19 per cent of the respondents, moderately effective for 67 per cent and ineffective for 14 per cent. The results indicate that the medium moderately effective for most yet the overall preference is for offline mode of education as students believe that it is more effective and they can be more involved in the learning process.

From the survey it was concluded that there is a deficit in kinesthetic tools which can introduce pre-reading skills to children with learning difficulties, hence a tool was developed in order to bridge this gap which was identified through the survey.

4.2 Development of Sensory Cards from Banana Stem Fibre for Children with Sensory Issues.

4.2.1 Processing of banana fibre

The banana stem was separated from the stem as a longitudinal strip which was further cut into small cubical pieces. The cubical pieces are then blended in a mixer which helps in obtaining fibres of even length. The extracted fibres were then boiled in hot water ($100° C$) for 10 minutes. This process improves the pliability of the fibres.

Plate 1- Processing of banana fibre

4.2.2 Preparation of maida based binding material

Maida and water was mixed in vessel till it forms a loose consistency. Further turmeric was added to this mixture that served as a natural antifungal and antibacterial agent, this helps to make the product fungi and bacteria proof. The mixture was then heated upon a stove. Once the mixture gets thicker and has a gel-like consistency, the stove was turned off and vinegar was added to it. Vinegar help is decreasing the pH. and makes the mixture more acidic. This binding material once cooled can be used for making the banana stem fibre mache.

Measurements for 1L of Maida based binding material

1. Maida – 30 gms
2. Turmeric – 5 gms
3. Water- 775 ml
4. Vinegar- 20 ml

Plate 2 - Maida based binding material

4.2.3 Preparation of the banana fibre mache

The extracted banana stem fibre and Maida was mixed in 10:1 ratio. Even mixing is important as it distributes the maida based glue all over the fibres. The mixture was kneaded until it forms a clay-like consistency. This mache prepared was further used as a substrate for preparation of the spell cards.

Plate 3 - Banana stem mache

4.2.4 Preparation of spell cards

The prepared mache was flatten into sheets of medium thickness and they formed the base of the spell cards. For the Alphabets, the texturing material which is rice bran was filled into the mould and the prepared mache was added to the same. The mould was refrigerated for an hour and then unmold. The prepared alphabets were then attached to the mache base prepared earlier and sundried for 3-4 days as per climatic conditions. The dried cards were cut into configuration boxes which the help of a cutting machine. Acrylic colours were used in the product and a wood finish was given to improve the acceptability.

Plate 4 - Processing of spell cards

Plate 5 - Spell cards from banana fibre

Content of the Product

- An Alphabet set
- Sensory cards for 40 letters from pre-primar Dolch's list
- General information leaflet
- Usage Manual
- Thank you card

Plate 6- Product Packaging

4.3 Evaluation of Tool

4.3.1 Expert evaluation of banana fibre sensory cards

Figure 11 indicates the tool evaluation scores based on individual criteria.

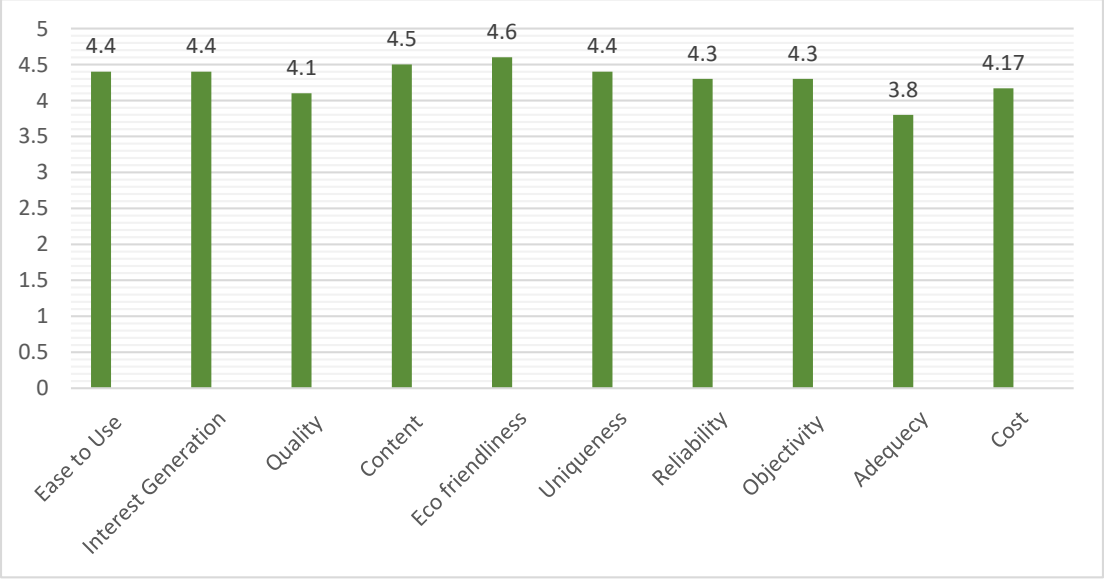

Fig 11- Tool evaluation scores

The evaluation was conducted through a self-prepared scoring sheet which consisted of 10 criteria which were important with regard to the developed tool. The minimum score of the evaluation tool was 1 and the maximum score was 5. Evaluation was conducted by 23 experts from the field of special education. The general scores attained were between 3.8 and 4.6 for different categories of evaluation.

The highest score was for its eco-friendly nature, the reason as explained by the experts was that the tools is totally eco-friendly and the upcycling of banana fibre with is an agricultural by product into something of value is very novel.

The content of the spell cards was well appreciated and the concept of progressing from alphabets to the letter in Dolch's list was commented to be adequate. The manual included with the tool aided in better comprehension of the users. The mean score attained was 4.5 out of 5 with regard to the content of the tool.

A score of 4.4 was obtained out of 5 for uniqueness, interest generation and for ease to use. The study was first of its kind to use banana fibre for the production of an educational tools especially in a situation where the market is flooded with plastic alternatives, the study is very unique in this aspect. The creative concept of including configuration boxes and colour coding for vowels and consonants generates interest in the user. Having textural variation within the tool is an added advantage. The tool is very simple to use and can be neatly stored in the box that is provided along with the tool.

The scores for reliability and objectivity of the tool was 4.3 out of 5 respectively. The tool is curated in a way that the child gradually learns the alphabets followed by the words in the pre-primary dolch's list. The activities suggested along with the tools assures that the primary objective i.e. the introduction early literacy concepts are satisfied which makes the product very objective. The product can be relied to introduce the concept of spelling in an innovative way.

The scores for cost and quality was 4.1 out of 5 which suggests that the product is of good quality and proper finishes are used to ensure that the quality standards are not compromised upon. The product is treated with turmeric and acetic acid with serves as a natural antifungal agent and an external wood finish is also used which improves the water resistance property. The cost

assigned for the product was Rs.500 which was commended was reasonable by the experts which compared to wood based alternative in the market.

A score of 3.8 out of 5 was given with regard to the adequacy of the product. Experts commended that the product can be paired with other supplementary material to improve the outcome in users. However, the product was commented as very effective for kinesthetic learners, who generally has difficulty in learning the concept of spelling in a regular classroom setup.

Few comments were also received which will help in further improvement of the product, there were suggestion to use black and white colour scheme in the product which will be more appealing in initial stages of administration. Experts also suggested the possibility of manipulating the same product into a jigsaw puzzle format which will lead to better involvement on part of the users. The overall comments regarding the tools was positive and the tool was administered to 5 students from Adarsh special school, Tripunithura. The students showed interest in the developed tool which indicates that the tool was effective.

4.3.2 Presentation of the tool at Kerala start up mission expo

The product was presented at Kerala start up mission expo on 28th May 2022. KSUM is the central agency of Government of Kerala for entrepreneurship development and incubation activities in Kerala, India. The expo was visited by students across the country and many of them were keen to understand about the developed product. The general positive opinion regarding the product was regarding the novelty as well as the wood like texture combined with low weight. Comments were also received on the potential for usage of the banana fibre based mache as a substitute for wood. The product was also mentioned in Beacon newsletter 2021-22, which was published by the department of Home science, St. Teresa's College(Autonomous), Ernakulam.

Plate 7- Excerpt from Beacon

Plate 8- Presentation at KSUM Expo

SUMMARY AND CONCLUSION

CHAPTER - 5

SUMMARY AND CONCLUSION

The study undertaken by the researcher was "***Development of Sensory Cards from Banana Stem Fibre for Children with Sensory Issues***". A survey was conducted associated with the same study on the effectiveness of virtual education for children with learning difficulties. The study was conducted in Rashmika school for Special education with the help of a self-designed questionnaire. It is a centre for children with learning difficulties, slow learning and attention deficit hyperactivity disorder. Purposive sampling technique was used throughout the study, 21 students were included in the survey on effectiveness of virtual education for children with learning difficulties. The results of the same survey indicated that the needs of kinesthetic and tactile learners were not being met and there is a scope for development of a learning tool which can be useful for kinesthetic and tactile learners. Subsequently, banana fibre based sensory cards were developed including the 40 letters of preprimar Dolch's list, individual alphabets kit and user manual for easy administration. The tool was evaluated by 23 experts from various special schools in Ernakulam including Assisi vidyaniketan public school thrikakkara, Adarsh special school Tripunithura, Raksha special school mattancherry, Cottolengo special school fort kochi. A self-prepared opinionnaire was used which included ten factors which are critical for study material like accessibility, interest generation, adequacy, eco-friendliness, adequacy etc. and a scoring between 1 to 5 was used for evaluation of the material. Hence it can be stated that three tool were used during the conduct of the study which included a questionnaire for evaluating the effectiveness of virtual education for children with learning difficulties, Banana stem based sensory cards and an opinionnaire for evaluation of developed tool. The sample included both student and teachers working in the field of special education. The data was collected, consolidated and analysed using percentage.

Findings

The findings of the study can be summarized as below

5.1 Survey on Effectiveness of Virtual Education for Children with Learning Difficulties

5.1.1 Background details of selected students with learning difficulties

- Thirty-five per cent of the respondents were 7 years of age

- Responses were majorly from students of 2 nd standard.
- Around eighty-one per cent of the respondents were from urban area
- Most of them (71%) had one sibling each.

5.1.2 Study environment at home

- Sixty three per cent reported that they were distracted during online classes.
- The major source of distraction was external sounds which accounted for 91 per cent followed by excessive visual input (14%), Curiosity to explore (9%) and chatting in between which was reported to be five per cent.

5.1.3 Assistance from teachers

- Ninety one per cent responded that they utilise online classes to clear their doubts.
- Sixty two per cent responded that they interact with teachers as per their need, twenty-nine per cent of the students had a regular interaction with their teachers and nine per cent rarely interacted with their teachers.

5.1.4 Attention span of students during online class

- Thirty three per cent responded that they can sustain their attention for 2- 4 hours, twenty nine per cent of students had an attention span between 1- 2 hours and another twenty nine could sustain their attention for more than 4 hours. Nine per cent of students indicated that they could hold attention for a period of less than 1 hour.

5.1.5 Types of learners and academic pressure during online class

- Thirty three per cent responded that they learned better when by writing notes, similarly thirty three per cent learned better when the topics are presented visually, nineteen per cent could understand the concept through hands on activities and fourteen per cent learned well when someone explained the topic to them.
- Eighty one per cent of the respondents believe that academic pressure has increased during online classes. Sixty six per cent of the respondents has also said that they are able to complete the tasks given by their teachers and fifty two responded that teachers are able to give equal attention to all the students in the class.

5.1.6 Functioning and major issues in online class

- Eighty one per cent preferred offline mode of examination and sixty-two per cent opted for offline learning materials.
- Fifty seven per cent of the students joined on time, 38 per cent were occasionally late and five per cent of the students were always late to join the classes.
- Thirty three per cent responded that they were unable to respond during classes, twenty-nine per cent said that they had a distractive environment at home while twenty-four per cent had the opinion that there was a lack of clarity in the concepts. Inattention was the major cause of concern for fourteen per cent of the respondents. Seventy per cent experienced lack of physical activity and seventy-six percent experienced a lack of practical experiences due to online mode of education.

5.1.7 Emotional and vision related difficulties experienced by children

- Eighty one per cent responded that they do not get an opportunity for peer interaction and seventy sic per cent had developed feelings of isolation during the pandemic period.
- Eighty six per cent responded that they experience eye strains during online classes. On enquiring regarding the type of difficulty 67 per cent experienced headaches, 19 per cent had watery eyes. Blurred vision was reported by nine per cent and double vision by five percent.

5.1.8 Effectiveness and involvement of the students

- Eighty five per cent of the students preferred offline education, ten per cent preferred online mode of education and five per cent preferred hybrid mode of education.
- Sixty two per cent rated their involvement as good, 19 per cent as excellent, fourteen per cent as fair and 10 per cent had poor involvement during class. Online mode of education was very effective for nineteen per cent of the respondents, moderately effective for sixty seven per cent and ineffective for fourteen per cent.

5.2 Development of Sensory Cards from Banana Stem Fibre for Children with Sensory Issues.

- The tool was prepared by processing the banana fibre was means of grinding the fibre to obtain smaller strands of fibre which was further boiled alongside turmeric and

vinegar to make the fibre fungi proof. The processed fibre was then combined with maida based binding material to make the banana stem based mache. The prepared mache was further added to moulds and then sundried to obtain the cards. The cards were cut in the form of configuration boxes, painted and wood finish was used to make the product more durable. The final content of the product included an Alphabet set

- Sensory cards for 40 letters from pre-primar , Dolch's list, General information leaflet, Usage Manual and Thank you card.

5.3 Evaluation of Tool

5.3.1 Expert evaluation

- The evaluation was conducted through a self-prepared scoring sheet which consisted of 10 criteria which were important with regard to the developed tool. The minimum score of the evaluation tool was 1 and the maximum score was 5. Evaluation was conducted by 23 experts from the field of special education. The general scores attained were between 3.8 and 4.6 for different categories of evaluation.
- The highest score was for the function of eco-friendliness. The mean score attained was 4.5 with regard to the content of the tool. A score of 4.4 was attained for uniqueness, interest generation and for ease to use. The scores for reliability and objectivity of the tool was 4.3 respectively. The scores for cost and quality was 4.1 and a score of 3.8 was given with regard to the adequacy of the product.

5.3.2 Presentation of the tool at Kerala start up mission expo

- The banana stem based sensory cards were presented at Kerala start up mission expo on 28th May 2022. KSUM. The product was appreciated by most of the participants of the exhibition.

Conclusion

The present study discusses on "Development of Sensory Cards from Banana Stem Fibre for Children with Sensory Issues". The study also includes a survey on effectiveness of virtual education for children with the learning difficulties. The survey included various factors like study environment at home, assistance from teachers, attention span etc. It was evident from the results

that the needs of kinesthetic and tactile leaners were poorly met and there is a scope of kinesthetic and tactile educational material.

The developed tool effectively satisfies the needs of tactile and kinesthetic learners and can be used to introduce pre reading skills to any type of learner. The scores of evaluation is a positive indication of the effectiveness of the developed tool.

Limitations

- Processing of the banana fibre without machinery aid is a cumbersome process.
- More products can be produced from developed banana stem mache.

Recommendations

The study put forth the following implications

- There is a need to incorporate activities which are suited to kinesthetic learners
- More educational tools must be made from eco-friendly alternatives
- The study can be extended covering a larger sample to produce more accurate and bigger database.

BIBLIOGRAPHY

BIBLIOGRAPHY

- A Baharin, N. A. (2015). Production of Laminated Natural Fibre Board from Banana Tree Wastes. *Recent Advances in Materials, Minerals and Environment* (pp. 999 – 1006). Procedia Chemistry.
- A. C. H. Barreto, M. M. (2010). Chemically Modified Banana Fibre: Structure, Dielectrical Properties and Biodegradability. *Springer* .
- A. Parre a, B. K. (2019). Investigation of chemical, thermal and morphological propertiesof untreated and NaOH treated banana fibre. *Materials Today.*
- Abayomi A.Akinwande, A. B. (2021). Infuence of alkaline modifcation on selected properties of banana fber paperbricks. *Nature portfolio*.
- Alexis R.Lauricella, E. W. (2015). Young children's screen time: The complex role of parent and child factors. *Journal of Applied Developmental Psychology*, 11-17.
- Amgad Elbehiry, O. E. (2020). Performance of concrete beams reinforced using banana fibre. *Case Studies in Construction Materials*.
- Ans Al Rashid, M. Y. (2020). Utilization of Banana Fibre-Reinforced Hybrid Composites in the Sports Industry. *Material* .
- Bibaswan Sen, S. P. (2021). Development of Novel Respiratory Face Masks Prepared from Banana Stem Fibre Against Bio-Aerosols: An Eco Friendly Approach. *Letters in applied nano bio science*, 1993 - 2002.
- Chandra, Y. (2020). Online education during COVID-19: perception of academic stress and. *Asian Education and Development Studies*.
- Chester, W. J. (2020). Improving the Properties of Banana Fibre Reinforced Polymeric Composites . *Procedia Engineering*, 283-289.
- Dr. Ismail A. Elhaty, D. T. (2020). Teaching University Practical Courses Online during COVID-19 Crisis: A Challenge for E learning. *Journal of Critical Reviews* .

- Dragan Kusic, U. B. (2020). Thermal and Mechanical Characterization of Banana Fibre Reinforced Composites for Its Application in Injection Molding. *Materials*.
- Duha Qutishat, R. O. (2022). An Overview of Attendance and Participation in Online . *International Journal of Interactive Mobile Technologies*.
- Erickson, H. C. (2017). Elementary Teacher Perceptions Regarding the Use of Kinesthetic Learning Strategies. *Walden Dissertations and Doctoral Studies*.
- Himadri Kalita, A. H. (2018). Development of banana (Musa balbisiana) pseudo stem fibre as a surgical bio-tool to avert post operative wound infections . *The Royal Society of Chemistry*.
- Ikechukwu Christian Ezema, A. R. (2014). Effect of Surface Treatment and Fibre Orientation on the Tensile and Morphological Properties of Banana Stem Fibre Reinforced Natural Rubber Composite. *Journal of Minerals and Materials Characterization and Engineering*, 216-222.
- J.Santhosh, N. (2014). Study of properties of banana fibre reinforced composites. *International Journal of Research in Engineering and Technology*.
- K. B. Prakash, Y. A. (2021). Influence of Fibre Volume and Fibre Length on Thermal and Flexural Properties of a Hybrid Natural Polymer CompositePrepared with Banana Stem, Pineapple Leaf, and S-Glass. *Hindawi*.
- K. M. Y. Arafat, J. N. (2018). Handmade paper from waste banana fibre. *Bangladesh journel of scientific and industrial research*, 83-88.
- Kelly r. Laurson, J. C. (2008). Combined Influence of Physical Activity and Screen Time Recommendations on Childhood Overweight. *The Journal of Pediatrics*.
- Krishnashree Achuthan, S. M. (2021). A novel banana fibre pad for menstrual hygiene in India: a feasibility and acceptability . *BMC Women's Health* .
- Laly a. Pothan, j. G. (2002). Effect of fibre surface treatments on the fibre–matrix interaction in banan stem composites. *Composite Interfaces*, 335-353.

- Leopold, L. (2012). Prewriting Tasks for Auditory, Visual, and Kinesthetic Learners. *Tesl Canada journal*.
- Li Duan, X. S. (2022). An investigation of mental health status of children and adolescents in china. *Journal of Affective Disorders*, 112-118.
- Lina Herrera-Estrada, S. P. (2015). Banana fibre composites for automotive and transportation application.*Research Gate*.
- Lissak, G. (2018). Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study. *Environmental Research*, 149-157.
- Lista Litta, H. A. (2015). The Effects of Visual Auditory Kinesthetic Learning Style as Technique in Improving Students' Writing Ability. *ELT Worl wide* .
- Louise L. Hardy, E. D.-W. (2010). Screen Time and Metabolic Risk Factors Among Adolescents. *ARCHPEDIATRICS*.
- M. A. Maleque, F. Y. (2007). Mechanical properties study of pseudo-stem banana fibre . *The Arabian Journal for Science and Engineering*.
- M.Y Abdulrahim, D. S. (2021). Hybridization of Polyester/Banana stem Fibre and Cow horn particulate composite for possible production of a military helmet. *International Journal of Sustainable Engineering*, 1170–1180 .
- N. Venkateshwaran, A. E. (2010). Banana Fibre Reinforced Polymer. *Journel of reinforced plastics and composites*.
- Nadezhda Almazova, E. K. (2020). Challenges and Opportunities for Russian Higher Education amid COVID-19: Teachers' Perspective. *Education sciences*.
- Nancy Csapo, R. H. (2006). The role of learning styles in the teaching/learning process. *Issues in Information Systems*.
- Naresh Kr Sharma, V. K. (2012). Studies on properties of banana fibre reinforced green composite. *Journal of Reinforced Plastics and composites*, 525–532.

- Rachel C. Colley, T. B. (2020). Exercise and screen time during the COVID-19 pandemic. *Statistics Canada*, 3-11.
- Ricardo Mello Di Benedetto, M. V. (2015). Influence of UV Radiation on the Physical-chemical and Mechanical Properties of Banana Fibre. *Materials Research*.
- Rosalina Richards, R. M. (2010). Adolescent Screen Time and Attachment to Parents and Peers. *Archpediatrics*.
- S. Prakash Chandar, K. G. (2018). Experimental investigation on the mechanical . *rasayan journel chem*, 640-646.
- S.Raghavendra, L. P. (2013). Mechanical Properties of Short Banana Fibre Reinforced Natural Rubber Composites. *International Journal of Innovative Research in Science, Engineering and Technology*.
- Satish Pujari, A. R. (2014). Comparison of Jute and Banana Fibre Composites: A Review. *International Journal of Current Engineering and Technology*.
- SOFFNER, S. J. (2000). Evaluation of the primary depithing of banana stem as pre-processing for pulping. Research Gate.
- Sunita Chauhan, S. A. (2014). Utilization of Pectinases for Fibre Extraction from Banana Plant's Waste. *International Journal of Waste Resources*.
- Wan Fatin Fatihah Yahya, N. M. (2015). Decision Support System for Learning Disabilities Children in Detecting Visual-Auditory-Kinesthetic Learning Style. *The 7th International Conference on Information Technology* . Research Gate.

APPENDICES

APPENDIX - I

VIRTUAL EDUCATION EVALUATION QUESTIONNAIRE

Instructions to candidates

- The pandemic situation and the shift of education to the virtual platform do have an impact on students. This study is aimed at finding the opinion of students regarding virtual education and the improvement they wish to bring in this system.
- Choose only one option
- Time Limit- 1 Hr

---

1. Name -

2. Age –

3. Class

4. Father's Occupation

5. Mother's Occupation

6. No. of Siblings

7. Area of residence

   a) Urban
   b) Rural

8. Education of parents

9. Which device do you use to attend online classes?

   a) Mobile Phone
   b) Laptop
   c) Tablet

10. Ownership of digital device

    a) Myself
    b) Father
    c) Mother
    d) Sibling

11. Do you have full access to the device during online classes?

a) Yes
b) No

12. How did you know about the online education platform?

a) Myself
b) Father
c) Mother
d) Sibling

13. Do you have connectivity issues?

a) Yes
b) No

14. Do you have a distraction free environment at home?

a) Yes
b) No

15. What is the major distraction that you face during online classes?

a) External Sounds
b) Curiosity to explore
c) Chatting in between
d) Too much of visual input

16. How often do you have a discussion with the teachers?

a) As per the need
b) Regularly
c) Rarely

17. Do you utilize the time in online class for clearing your doubts?

a) Yes
b) No

18. How long can you sustain the attention during the virtual class?

a) Less than 1 hour
b) 1-2 hour
c) 2-4 hour
d) More than 4 hour

19. When do you learn better?

a) When someone explains the concept to you
b) When the topics are presented visually
c) Through hands on activity
d) By writing notes

20. By what time do you wake up for online classes?

a) 6 AM
b) 10 AM
c) 12 PM

21. Do you have proper breakfast before joining online class?

a) Yes
b) No

22.Do you get breaks during online classes?

a) Yes
b) No

23. Do you feel that academic pressure has increased during online classes?

a) Yes
b) No

24. Do you prefer online or offline exams?

a) Online
b) Offline

25. Do you have an effective feedback system for online classes?

a) Yes
b) No

26. Do you experience eye strain during online classes?

a) Yes
b) No

27. Do you prefer the learning material to be provided online or offline?

a) Yes
b) No

28. Do you feel isolated while attending online class?

    a) Yes
    b) No

29. Do you miss your friends

    a) Yes
    b) No

30. Do you join on time for online classes?

    a) Yes
    b) No
    c) Occasionally late

31. Are you able to complete the tasks given by teachers on time during online sessions?

    a) Yes
    b) No

32. Does the teacher complete the syllabus on time during online classes?

    a) Yes
    b) No

33. Do you think that the teacher is being able to give equal attention to everyone in the class?

    a) Yes
    b) No

34. Do you get any hands on experience during virtual classes?

    a) Yes
    b) No

35. Do you experience any of these health issues due to increased screen time?

    a) Headaches
    b) Watery Eyes
    c) Blurred Vision
    d) Double Vision

36. Major problem that you face while attending online class?

    a) Inattention
    b) Lack of clarity in concept

c) Inability to respond
d) Distractive environment at home

37. Do you get opportunity for peer interaction?

a) Yes
b) No

38. Do you get time for physical activity like games?

a) Yes
b) No

39. How will you rate your involvement in class?

a) Excellent
b) Good
c) Fair
d) Poor

40. How effective is virtual education for you?

a) Very effective
b) Moderately effective
c) Ineffective

41. If given an option which one will you prefer?

a) Online
b) Offline
c) Hybrid

41. In addition to the above, would you like to provide any personal opinion on virtual media If so…

APPENDIX-II

OPINIONNAIRE TO EVALAUTE THE DESIGNED TOOL

Name-

Designation -

Attribute	Excellent (5)	Very good (4)	Acceptable (3)	Less acceptable (2)	Poor (1)
Ease to use					
Interest generation					
Quality					
Content					
Eco-friendliness					
Uniqueness					
Reliability					
Objectivity					
Adequacy					
Cost					