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Development of sensory cards from banana stem fibre for children with learning difficulties

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Abstract
Banana fibre is one of the strongest natural fibre with excellent tensile strength. The potential of this fibre is extensively explored in the textile industry but not in any other allied fields. The present study investigates the possibility of using banana fibre as a substrate for developing the sensory cards, which will be of immense use to children with learning difficulties. The developed cards will help children in establishing pre-reading skills, which is a crucial concept regarding their future education. The efficiency of the developed tool was evaluated by experts working in the field of special education. The results indicated the sensory cards would be of immense benefit to children with learning difficulties.

Keywords: Banana fibre, sensory cards, learning difficulties

1. Introduction
One of the strongest natural fibres in the world is banana fibre, sometimes referred to as musa fibre. The natural fibre, which is made from the stem of the banana tree and is extremely durable, is biodegradable. The fibre is mostly made of cellulose, hemicelluloses, and lignin and is made up of thick-walled cell tissue that is joined together by natural gums. Natural bamboo fibre and banana fibre are similar, but banana fibre has higher spinability, fineness, and tensile strength. The manufacturing of industrial textiles from banana fibres has been overtaken in recent years by the global consumption of banana fruit. A person consumes about 11.9 kilogramme of bananas annually on average. However, because banana plants only bear fruit once before dying, more than a billion tonnes of banana tree stems are discarded each year. 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) [2]. 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) [6]. The banana stem has been utilised extensively in the textile industry, but less is known about its potential as a raw material in other industries. This study intends to introduce the idea of sustainable educational materials as the most efficient strategy to reduce the load of plastic waste while also being more cost-effective. The most intriguing aspect of this study is how early sustainability education might help shape future generations of citizens who will take care of the environment. 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 a 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 Dolch's list was chosen to design the spell cards. It is also an effective method through which banana stem, which constitutes a majority of the agriculture waste in a plantain industry, includes 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 a manufacturing unit for this product can create employment opportunities for many, and sourcing the raw material directly from farmers can serve as an additional income for the farmers. The product can be produced at a low cost. It can be a revolution in the field of educational material as it is a sustainable product which has been produced by up cycling

agricultural waste.

Pre-reading, including 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 designed in the form of configuration boxes is very useful. The product is durable like wooden products, provided it is stored in a clean and dry environment. The concept of sustainability is growing, and this product is way better than plastic alternatives already available on the 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 and visual learners and is a novel approach to introducing sight words to children. Hence, this product will cater to the needs of a large category of children.

2. Methodology

2.1 Processing of banana fibre

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

Fig 1: Chopped banana stem

Fig 2: Processed banana stem fibres

2.2 Preparation of refined wheat flour based binding material

Refined wheat flour and water were mixed in the vessel till it formed 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 up on a stove. Once the mixture got thicker and had a gel-like consistency, the stove was turned off, and vinegar was added. Vinegar help decrease 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 refined wheat flour based binding material

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

Fig 3: Refined wheat flour based binding material

2.3 Preparation of the banana fibre mache

The extracted banana stem fibre and refined wheat flour were mixed in a 10:1 ratio. Mixing is essential as it distributes the refined wheat flour based glue all over the fibres. The mixture was kneaded until it formed a clay-like consistency. This mache prepared was further used as a substrate for the preparation of the spell cards.

Fig 4: Banana stem mache

2.4 Preparation of spell cards

The prepared mache was flattened into sheets of medium thickness and formed the spell cards' base, 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 per climatic conditions. The dried cards were cut into configuration boxes with the help of a cutting machine. Acrylic colours were used in the product, and a wood finish was given to improve the acceptability.

Fig 5: Base for sensory cards

Fig 6: Processing of sensory cards

Fig 7: Sensory 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

Fig 8: Product Packaging

A self-prepared opinionnaire was prepared for evaluation of the banana fibre sensory cards. Ten factors critical for study material like accessibility, interest generation, adequacy, eco-friendliness, etc., were included, and scoring between 1 to 5 was used for evaluation of the material.

Table I: Opinionnaire for evaluation

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					

3. Results and Discussions

Figure 9 indicates the tool evaluation scores based on individual criteria.

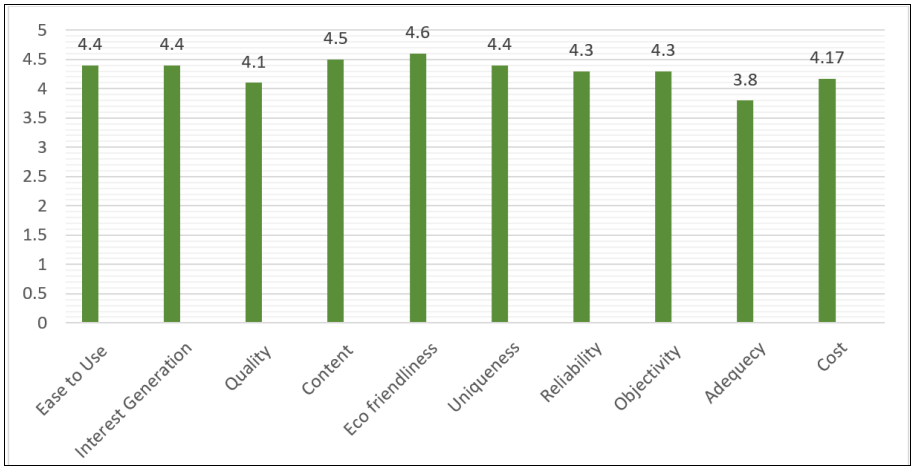

Fig 9: Tool evaluation scores

The evaluation was conducted through a self-prepared scoring sheet which consisted of 10 criteria which were important about the developed tool. The minimum score of the evaluation tool was one and the maximum score was 5. The 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 evaluation categories.

The highest score was for its eco-friendly nature; the reason, as explained by the experts, was that the tools are totally eco-friendly and the up cycling of banana fibre, which is an agricultural cause means product 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 about the content of the tool.

A score of 4.4 was obtained out of 5 for uniqueness, interest generation and ease of use. The study was the first of its kind to use banana fibre for the production of educational tools, especially in a situation where the market is flooded with plastic alternatives; the study is 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 device is very simple to use and can be neatly stored in the box that is provided along with the agency.

The tool's reliability and objectivity scores were 4.3 out of 5, respectively. The device is curated so that the child gradually learns the alphabet followed by the words in the pre-primary Dolch's list. The activities suggested along with the tools assure that the primary objective, i.e. the introduction of early literacy concepts, is satisfied, which makes the product very objective. The product can be relied on to introduce the concept of spelling in an innovative way.

The scores for cost and quality were 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. The product is treated with turmeric and acetic acid, which serves as a natural antifungal agent and an external wood finish is also used to improve, exterior 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 about the adequacy of the product. Experts commended that the product can be paired with other supplementary material to improve user outcomes. However, the product was commented as very effective for kinesthetic learners, who generally have difficulty learning the concept of spelling in a regular classroom setup.

A few comments were also received which will help in further improvement of the product; there; there were suggestions to use the 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 of the part of the users. The general comments regarding the tools were positive, and the device 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. Conclusion

The evaluation of the developed tool was conducted through a self-prepared scoring sheet which consisted of 10 criteria which were important about the developed tool. The minimum score of the evaluation tool was one and the maximum score was 5. The 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 evaluation categories.

The highest score was for the function of eco-friendliness. The mean score attained was 4.5 about the content of the tool. A score of 4.4 was achieved for uniqueness, interest generation and ease of use. The reliability and objectivity of the tool were 4.3, respectively. The scores for cost and quality were 4.1, and a score of 3.8 was given to about the adequacy of the product. The study puts forth the concept of sustainable educational material, and the developed material and is also used as an alternative to wood in similar educational products

5. Statements and Declarations

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