Design and Development of a Multisensory Tactile Teaching Aid Tool for Clothing Vocabulary Learning among Year Two Primary School Students

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ABSTRACT

This study documents the user-informed design and preliminary classroom testing of a multisensory tactile teaching aid for Year 2 English clothing vocabulary in Malaysia. The project was contextualised to the Kurikulum Standard Sekolah Rendah (KSSR) English curriculum, through preliminary teacher interviews and classroom observation records. Three Industrial Design students developed alternative concepts and physical mock-ups. Subsequently, 14 Industrial Design students evaluated the concepts against 11 design criteria; Student 1 received the highest aggregate score (637), followed by Student 2 (555) and Student 3 (511). The selected concept was developed into a portable tool, a freestanding tabletop board that incorporates a few components, including tactile fabric samples, removable clothing pieces, a spinner, writing activities, supplementary QR code access, a scoreboard, and storage. Classroom prototype testing involved 26 pupils of Year 2 at Sekolah Kebangsaan Dato' Naning, Alor Gajah, Melaka. Direct observations of pupils and verbal feedback indicated interest, enjoyment, active interaction, and perceived benefits from touching and comparing fabric samples. These findings support the design's preliminary acceptability and potential for engagement. The study presents a traceable design process that links curriculum-related needs and classroom conditions to the development of tangible educational products.

Keywords: Industrial Design; tactile teaching aid; English vocabulary; multisensory learning; tangible interaction; KSSR; Year 2

INTRODUCTION

Vocabulary knowledge is essential to early English language learning, enabling pupils to connect words to objects and actions and to convey meaning. Nation (2001) distinguishes vocabulary knowledge from simple word memorisation and highlights the importance of meaningful encounters with words. Young learners may benefit from instruction that makes concrete vocabulary accessible through familiar representations and activities such as multisensory tactile teaching aids. Conventional worksheets, pictures, and projected activities are useful for presenting words but cannot convey fabric textures except through direct touch.

Multisensory learning and embodied cognition provide theoretical support for investigating physical interaction (Shams & Seitz, 2008; Barsalou, 2008). More specifically, Bara and Kaminski (2019) found advantages to handling real objects over viewing images for foreign-language vocabulary learning among children aged 5 to 10. The studies justify exploring a tactile tool, but they do not establish the effectiveness of this particular design.

Much research supports meaningful object handling, sensory enrichment, and tangible interaction as plausible educational design strategies. In Malaysia, under the Kurikulum Standard Sekolah Rendah (KSSR), the Year 2 English Dokumen Standard Kurikulum dan Pentaksiran (DSKP) incorporates a multisensory, tactile teaching-aid approach in Unit 7, “Get Dressed,” as part of the primary school English curriculum. This approach introduces vocabulary for clothing and materials (Ministry of Education Malaysia [MOE], 2017). These words provide a specific curriculum-related justification for exploring tactile material references.

Although the tactile approach has proven useful for classroom learning, its effectiveness and its curriculum relevance have not been independently assessed. Hence, these gaps motivated the development of an integrated tabletop teaching aid that could combine material exploration with clothing vocabulary activities.

Research Objectives

The study aimed to:

1. Identify the instructional and classroom requirements for teaching Year 2 clothing vocabulary.
2. Develop teaching aid concepts through an Industrial Design process.
3. Investigate pupils' engagement, enjoyment, interaction, and perceived understanding during preliminary testing of the classroom prototype.

LITERATURE REVIEW

Early vocabulary learning, multisensory and embodied vocabulary instruction

Nation (2001) argues that vocabulary learning requires connections between forms and meanings across meaningful encounters. Bara and Kaminski (2019) studied foreign-language vocabulary learning in children aged 5 to 10 and found better memorisation of vocabulary while handling real objects compared to words paired with pictures. This age-relevant evidence provides a direct rationale for using real objects, for instance, fabrics and clothing components, although the study used a different intervention and setting.

An example of an integrated curriculum can be found in the Year 2 English DSKP, which provides the relevant Malaysian curriculum context for the design's development. Its "Get dressed" unit includes clothing words and material descriptions such as cotton, leather, wool and woollen (MOE, 2017). A tactile teaching aid concept uses physical samples alongside illustrations and vocabulary activities.

Shams and Seitz (2008) describe the potential benefits of training involving complementary sensory modalities. Barsalou (2008) proposes that cognition is grounded in perception and action, while Macedonia (2019) discusses educational implications of embodied learning. Andrä et al. (2020) reported that gesture- and picture-enriched instruction improved foreign-language vocabulary performance among eight-year-old school children compared with non-enriched instruction. Mathias et al. (2022) examined enriched vocabulary training among older school children, highlighting age-related differences. These findings motivate meaningful sensory enrichment rather than the indiscriminate addition of stimuli.

Tangible and interactive educational product design

Tangible interaction links information to manipulable physical elements. Ishii and Ullmer (1997) introduced a foundational vision of tangible interfaces; Hornecker and Buur (2006) emphasised physical manipulation, spatial interaction and social facilitation. These principles suggest attention to graspable components, readable representations, stable placement, and shared activity for a classroom. The proposed dress-up pieces, tactile samples, and spinner are intended to provide opportunities for such interaction.

Instructional clarity and human-centred design

Multifunctional teaching aids can create competing demands on attention. Mayer and Moreno (2003) discuss the importance of managing cognitive load in instructional design. Human-centred design principles also emphasise of being contextual by understanding users and evaluating designs iteratively (ISO 9241-210:2019). Classroom constraints and teacher needs are used to improve the product configuration, while peer concept appraisal and classroom testing informed preliminary evaluation. These approaches do not replace age-appropriate usability and learning-outcome testing.

Synthesis and research gap

In the Malaysian Year 2 classroom context, it is less established whether the combination of fabric samples, clothing manipulatives, and play-based tasks is practical and effective.

METHODOLOGY

Study design and setting

An exploratory, user-informed Industrial Design approach combined preliminary qualitative methods through iterative physical concept development, descriptive concept evaluation, and classroom prototype testing. The school context was Sekolah Kebangsaan Dato' Naning, Alor Gajah, Melaka. Preliminary classroom observation documentation was dated October 29, 2025.

Participants and their distinct roles

Three Industrial Design students independently generated concepts and physical mock-ups, each of the concepts labelled Student 1, Student 2 and Student 3. They developed initial sketches, refined a design concept, and produced a physical mock-up. Consecutively, a total of 14 Industrial Design students evaluated the concepts using 11 design criteria: educational value, age appropriateness, safety, engagement, interactivity, inclusiveness, clarity, flexibility, cultural relevance, cost, and durability. For the final classroom prototype testing, 26 of Year 2 pupils participated. Preliminary requirements were informed by face-to-face interviews with two Year Two English teachers, documented through written notes and audio recordings. The teachers' recruitment procedure requires author verification.

Ideation, mock-ups and comparative evaluation

The recorded aggregate criterion scores were compared descriptively without inferential statistics. Fourteen Industrial Design students rated each concept against 11 criteria on a five-point scale (1 = Very Poor; 2 = Weak; 3 = Satisfactory; 4 = Good; 5 = Excellent). Criteria were equally weighted, and scores were summed across evaluators (maximum 70 per criterion and 770 per concept). Individual evaluator-level score distributions were not analysed in the present report.

Teacher interview and preliminary classroom observation

The teacher interviews examined difficulties in integrating multisensory tactile teaching aids using the "Get dressed" topic, based on pupils' comprehension, engagement strategies, diverse learning needs, and classroom resources. Relevant Malay-language statements were translated into English. Classroom observation records a few key elements such as desk-based instruction, projected learning resources, drawing tasks, teacher guidance, participation, and restricted movement space. Interview and observation materials were grouped into descriptive themes according to Braun and Clarke (2006). Neither a complete formal thematic analysis nor an intercoder reliability procedure was documented. The two teacher interviews were conducted face-to-face, with written notes and audio recordings used to document responses. Interview and classroom observation evidence was organised into descriptive categories to inform design requirements; a fully documented formal thematic analysis was not undertaken.

Prototype development and usage

Student 1's selected concept was developed into a portable teaching aid tool. The teaching tool is an angled, freestanding tabletop board with a handle, fabric samples, clothing-shaped pieces, illustrated figures, a spinner, QR code-based access to learning, a scoreboard, and storage components. The product guideline described an eight-stage interaction sequence: Touch; Take and Stand; Scan; Roll and Read; Write; Dress-Up; Marks; and Store. The eight-stage sequence was developed collaboratively by the researcher and student designer. Before the classroom session, Industrial Design students participated in a separate pilot test in which they tried the complete sequence. Following the pilot test, the activity instructions or sequence were modified as part of iterative refinement.

Classroom prototype testing and qualitative feedback

The prototype was introduced to 26 Year 2 pupils in facilitated classroom activities. Verbal feedback was obtained from direct classroom observation and pupils. The observation focused on visible interest, participation, handling of clothing components, tactile exploration, enjoyment, and perceived understanding. The photographs corroborated the narrative of physical use as evidence. Feedback was solely summarised descriptively. A structured usability observation checklist was also completed during the classroom activities; ratings are presented separately in Table 7. No frequency counts of verbal responses, verbatim pupil transcripts, vocabulary pre-test/post-test or retention measure were available. Therefore, the present study documents development and initial user responses without claiming causal learning benefits.

Classroom usability observation was conducted on 6 February 2026 with 26 Year Two pupils aged seven to eight. One Industrial Design student observer recorded notes and one score per pupil for each of eight criteria during the activities, while two other Industrial Design students assisted with facilitation. The activities involved examining the product and explaining its use, touching cotton, wool and leather, operating the spinner, identifying or matching materials, and commenting on ease or difficulty. The eight criteria were ease of use (U1), instruction clarity (U2), touch/material interaction (U3), spin operation (U4), label/visual clarity (U5), engagement (U6), material identification (U7), and satisfaction (U8). Ratings followed a five-point scale: 1 = Very Poor (unable even with assistance); 2 = Poor (major difficulty and significant assistance); 3 = Moderate (some assistance); 4 = Good (minimal assistance); and 5 = Excellent (independent, easy and confident completion). Scores were summarised descriptively by frequency and mean. Engagement and satisfaction were observer ratings, not pupil self-reports.

Ethical considerations

School permission, guardian consent, pupil assent and any applicable institutional ethical review were obtained before publication. Images of pupils were not published without appropriate permission where anonymised images are preferable when permission is uncertain.

RESULTS

Teacher interview findings

A key teachers statement were: “The ‘Get Dressed’ topic is difficult because I need to bring fabric materials to demonstrate”. The statement indicates a lack of practicality in integrating physical material references. Additional interviews addressed differences in English comprehension, the value of guidance and the use of digital tools such as Wordwall, Quizizz and Kahoot. These observations were treated as contextual needs for teaching tools rather than as overall claims about Year 2 classrooms.

Table 1. Teachers interview themes and design implications

Theme	Identified need	Design response
Physical demonstrations	Accessible material examples	Integrated fabric samples
English comprehension	Visual and contextual cues	Clothing illustrations and pieces
Engagement	Interactive activities	Spinner and dress-up tasks
Diverse learning needs	Guided participation	Facilitated activity structure
Resource management	Organised teaching resources	Handle and storage

Classroom observation findings

Observation documented teacher-guided desk-based activities, projected learning resources, drawing tasks, and varying levels of comprehension. Limited space for movement supported the decision to develop a compact tabletop product rather than a floor-based activity.



Fig. 1 Classroom Observation

Table 2. Classroom observations and corresponding requirements

Observed condition	**Design requirement**
Limited space between desks	Compact freestanding tabletop configuration
Teacher-guided instruction	Clear activity sequence
Different levels of comprehension	Visual support and manageable instructions
Pupil participation in tasks	Hands-on learning opportunities
Multiple teaching resources	Integrated, reusable product

Research-to-design traceability

Table 3. Traceability from evidence to final features

Research evidence	**Design requirement**	**Prototype feature**
Teacher brings fabrics to class	Accessible physical samples	Tactile fabric swatches
Comprehension varies	Visual–physical associations	Illustrations and clothing pieces
Interactive tasks encourage participation	Manipulable activities	Spinner and dress-up pieces
Guidance is important	Structured task progression	Eight-stage usage sequence
Desk space is constrained	Tabletop usability	Freestanding board
Materials need organisation	Portability and storage	Handle and storage components

Comparative concept evaluation

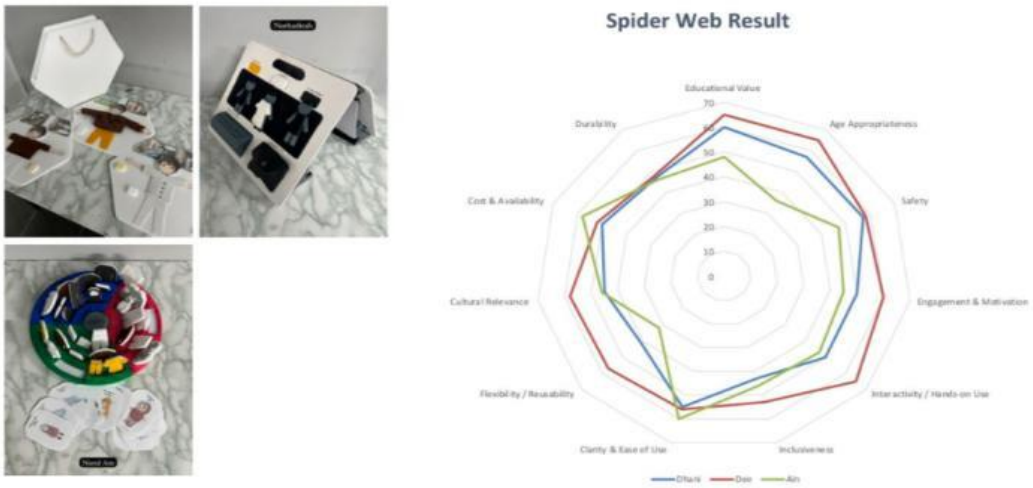

Fig. 2 Concept Evaluation

Table 4. Aggregate concept evaluation scores (14 Industrial Design evaluators)

Criterion	**Student 1**	**Student 2**	**Student 3**
Educational value	65	60	48
Age appropriateness	65	57	36
Safety	58	57	47
Engagement and motivation	60	50	45
Interactivity and hands-on use	65	50	47
Inclusiveness	53	43	46
Clarity and ease of use	56	55	60
Flexibility and reusability	57	41	32
Cultural relevance	58	45	46
Cost and availability	52	50	58
Durability	48	47	46
Total	637	555	511

Student 1's concept obtained the highest total score (637), followed by Student 2 (555) and Student 3 (511). Student 3 received the highest ratings for clarity/ease of use and cost/availability, indicating strengths in an alternative concept. These scores supported formative concept selection. However, the measure does not specifically assess child usability or learning effectiveness.

Final prototype and interaction sequence

The refined prototype combined fabric references, removable clothing components, an angled tabletop board, task selection, writing activities, digital access, and storage. The design was intended to integrate several

activities into a single portable teaching aid tool. Physical durability and independent operation were not systematically measured.

A separate pilot test with Industrial Design students involved trying the complete eight-stage usage sequence. The instructions or sequence were subsequently modified, although the specific revisions were not documented in the available information. Accordingly, the pilot is evidence of formative refinement, not proof that the sequence was validated or that it improved vocabulary learning.

Table 5. Documented eight-stage usage sequence

Stage	Action	Intended function
1	Touch	Explore fabric textures
2	Take and Stand	Position board
3	Scan	Access supplementary QR activities
4	Roll and Read	Select and read task
5	Write	Complete vocabulary or sentence activity
6	Dress-Up	Arrange clothing pieces
7	Marks	Record activity points
8	Store	Return components

Classroom prototype testing: observation and pupil feedback

During classroom testing with 26 Year 2 pupils, the reported observations and verbal feedback were generally positive. Pupils showed interest in the teaching aid tool, improved handling of clothing-shaped components, and participated in facilitated play-based tasks. Verbal feedback indicated enjoyment of the activities and a perception that touching and feeling fabric samples helped pupils understand differences among the materials introduced.

The tactile samples provided direct experience of fabric characteristics, while the clothing pieces enabled physical manipulation during vocabulary-related activities. These two qualitative sources, behaviour and verbal feedback, converged in indicating a favourable immediate user experience. However, these findings do not differentiate whether every pupil expressed each view or how many pupils gave each response.

Pupils' reported understanding is treated as perceived understanding rather than objectively measured through an assessment. No standardised vocabulary test, comparison condition, or retention measure was available.

The structured usability observation yielded 208 ratings (26 pupils × eight criteria). Of these, 206 (99.0%) were rated 5 and two (1.0%) were rated 4, producing an overall mean of 4.99/5.00. Seven criteria had means of 5.00; material identification (U7) had a mean of 4.92 because two pupils received a rating of 4. These are observer-assigned usability scores rather than counts of particular observed behaviours or evidence of vocabulary gains. The concentration of maximum scores indicates a possible ceiling effect.



Fig. 3 Classroom Prototype Testing

DISCUSSION OF INSTRUCTIONAL DEMANDS AND STUDY LIMITATIONS

The combination of tactile samples, clothing pieces, spinner, QR activities and writing tasks provides multiple opportunities for interaction but may also increase cognitive demands if several features are introduced simultaneously. In line with the cognitive-load concerns discussed by Mayer and Moreno (2003), future classroom use should consider clear instructions, appropriate pacing and teacher guidance. Cognitive load was not directly measured in this study. The findings are also limited by the single-school sample of 26 pupils, single-observer usability scoring, possible ceiling effects, and absence of standardised vocabulary learning or retention assessments. The formative pilot test did not independently establish the instructional effectiveness of the eight-stage sequence**.**

Table 6. Descriptive classroom testing findings (n = 26)

Theme	**Observation**	**Reported verbal feedback**	**Interpretation**
Interest	Pupils explored the product	Positive responses to activities	Encouraging engagement
Enjoyment	Participation in play-based tasks	Enjoyment expressed	Positive immediate experience
Hands-on interaction	Clothing pieces handled	Positive response to manipulation	Active participation
Tactile exploration	Fabric samples touched and felt	Touch described as helpful	Material exploration valued
Understanding	Materials explored during tasks	Perceived clearer understanding	Perceived benefit; not measured gain

Table 7. Structured classroom usability observation ratings (n = 26)

Criterion	**Score 5, n (%)**	**Score 4, n (%)**	**Mean / 5**
U1 Ease of use	26 (100%)	0 (0%)	5.00
U2 Instruction clarity	26 (100%)	0 (0%)	5.00
U3 Touch/material interaction	26 (100%)	0 (0%)	5.00
U4 Spin operation	26 (100%)	0 (0%)	5.00

U5 Label/visual clarity	26 (100%)	0 (0%)	5.00
U6 Engagement	26 (100%)	0 (0%)	5.00
U7 Material identification	24 (92.3%)	2 (7.7%)	4.92
U8 Satisfaction	26 (100%)	0 (0%)	5.00
Overall (208 ratings)	206 (99.0%)	2 (1.0%)	4.99

Scores were assigned by one observer during classroom activities; two other students assisted with facilitation. Overall percentages use 208 ratings; criterion percentages use 26 pupils. No inter-rater reliability estimate is available.

CONCLUSION

This study developed a curriculum-relevant multisensory tactile teaching aid tool for Year 2 clothing vocabulary through an exploratory Industrial Design process. Preliminary teacher interviews and classroom observation findings confirmed the tool requirements. Although the observations and verbal feedback indicated a positive classroom experience, this research did not measure improvement in English vocabulary, encouraging further development and evaluation of the teaching aid tool. Future research should examine learning outcomes, usability, teacher practicality, and durability using systematic methods.

Declarations

Before data collection, permission to conduct the study was obtained from the Headmaster of Sekolah Kebangsaan Dato' Naning, Alor Gajah, Melaka. The approval allowed the researcher from Universiti Teknologi MARA (UiTM) to conduct their research activities on the school premises.

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