Loving Baby: An AI-Supported Robotic Companion for Primary Education – Early Evidence on Emotions, Engagement and WellBeing

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Abstract

Emotions, engagement and well-being are fundamental to primary students' learning. Existing work on craft-based interventions and social robots shows benefits for creativity, mood and engagement. However, they rarely target young disaster-affected learners or integrate craft and AI companions to support socio-emotional recovery, such as community-level trauma. This study investigates *Loving Baby*, an AI-supported robotic companion embedded in a craft workshop for 96 primary students. The robot provides self-determination theory (SDT)-informed emotional and scenario support while students design tailored clothes and write heartfelt words. SDT is administered pre- and post- workshop and shows significant improvements ($p < .01$) in behavioural, emotional and cognitive engagement, and motivation ($p < .05$). Internal consistency is excellent (Cronbach's α = .955), with strong inter-correlations between subscales (r = .78–.88), indicating a coherent engagement construct. Students also reveal rich emotional labelling (joy, sadness, anger, fear), links between happiness and helping others, and perspective-taking towards peers and *Loving Baby*. The findings provide initial evidence that an AI-supported robotic companion with a craft workshop can enhance engagement and motivation while opening a safe space for emotional expression in a post-disaster primary context.

Keywords

Social Robot, Engagement, Well-Being, Emotions, Self-determination Theory, AI Companion

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1 Introduction

Emotional experiences, engagement and well-being are increasingly recognised as central to students' active participation, learning motivation and persistence, especially when learners are coping with adversity [23, 26]. Building on this affective emphasis, self-determination theory (SDT) explains how need-supportive environments can shape students' emotional experiences. SDT highlights that emotions linked to autonomy, competence and relatedness underpin sustained engagement and motivation [22].

Recent works with primary students show that when psychobiological needs are supported, learners display higher engagement and stronger motivation [7, 27]. For children who have experienced community-level trauma, such as the 2025 Wang Fuk Court fire in Tai Po [1], supporting emotional recovery and everyday well-being alongside academic learning is a pressing educational priority.

Using arts and crafts to foster creativity, emotional expression, social connection and psychological well-being is common [6]. Huotilainen et al., [15] mentioned that our brains love arts and crafts because they engage embodied cognition, activate mirror neurons, and promote brain plasticity. Handling materials helps regulate mental states, induce a rewarding state of flow, and reduce stress. Crafts provide a safe space to fail and manage emotions [4], while sensory-motor stimulation supports learning and well-being [13]. These activities are tightly woven into human cognition, enhancing relaxation, recovery, and social bonding. A recent systematic review of craft-based interventions found consistent short-term improvements in stress, mood, self-esteem, sociability, and broader mental well-being across diverse populations [3].

On the other hand, AI-empowered and robot-supported learning environments have opened new possibilities for supporting the affective dimension of learning [5, 11]. Affective computing enables AI to recognise and respond to learners' emotional states, fostering more engaging interactions [25]. For example, automatic facial expression identification during lectures helps teachers adjust interventions and positively influencing emotional experiences [24]. Another example is Fung et al. [12], who designed and developed a humanoid robot system with SDT to support traditional Chinese language learning. Compared with a teacher-led control group, children who learned with the robot showed significant improvement in learning engagement and motivation over a five-day program.

Social robots have also been used as playful companions to stimulate children's creativity during storytelling and open-ended play [14]. In creativity-focused interventions with the YOLO robot, interaction with the robot led to more original ideas and richer narrative production [2]. Studies integrating social robots into storytelling and arts-and-crafts activities suggest that such hybrid interventions can nurture children's creative potential and curiosity [20].

[1]Tai Po inferno: Hong Kong's deadliest fire in decades: https://multimedia.scmp.com/infographics/news/hong-kong/article/3334304/taipo_wangfuk_fire/index.html

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Figure 1: *Loving Baby* can be programmed to perform different facial expressions, gestures, and interaction.

However, the craft–technology contexts have prioritised creativity and learning outcomes, with less attention to children's emotions, well-being, or active participation.

To our best knowledge, there is very limited empirical work examining how an AI-embedded craft workshop might support primary school children's emotions, engagement, and well-being in a post-disaster setting, such as the Wang Fuk Court fire, where learners face academic and socio-emotional challenges.

This work addresses the gap by investigating how an AI-supporte d robotic companion supports students' engagement and socio-emotio
nal experience. The study focuses on two research questions: (RQ 1) How does interacting with *Loving Baby* impact students' learning engagement and motivation? and (RQ 2) How do students perceive their emotional experience and sense of well-being when interacting with *Loving Baby*? To address two RQs, we designed a workshop and developed an AI-supported robotic companion, *Loving Baby*, for 96 primary school students. The study offers preliminary evidence and design insights for future development.

2 Methods

The study employed a two-stage approach: (1) system development and (2) empirical study. In this section, we discuss the system design, including two systems, the empirical study design, participants, inclusion criteria, and regulations.

2.1 System Design

Loving Baby is a human-like robot with a 10-inch screen that displays learning content, conversation, and visual elements. It can be programmed to perform different facial expressions, gestures, and interactions (seven motors: neck, hands, joints and fists) (Fig. 1). The interactive elements can mimic human actions and trigger learning motivation and engagement. We designed and developed two systems to interact with students and support their emotions, engagement and well-being. We developed two systems: (1) AI-empowered emotional supported system (AI-E2S) and (2) AI-empowered scenario supported system (AI-3S). In the pilot trial, participants were free to explore the functions and interact with the embedded systems. Each student has an individual account to access to each system for six-month. We will monitor the interaction accordingly.

(1) AI-empowered emotional supported system (AI-E2S). AI-E2S was developed and deployed using Roflow. It is NUWA's [19] cloud-b ased and embedded workflow editor for robot interactions. Roflow provides a visual, drag-and-drop interface in which the developer defines a project, selects the robot model and skin, and then chains

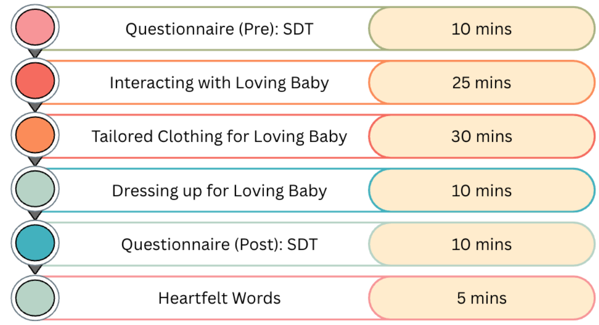

Figure 2: The overview of the study procedure.

modular blocks (e.g. triggers, dialogue, expressions, media, and sensing) into a service flow. Through the integration with ChatGPT 5 [2], *Loving Baby* can act as different roles (e.g., peer and educational psychologists) to chat and share emotions with students. *Loving Baby* can also sing a song and dance with students (three wheels at the bottom).

(2) AI-empowered scenario supported system (AI-3S). AI-3S comprised multiple encouraging stories to foster students' positive thinking. The stories cover emotional support for individuals, peers and family, a sense of security, overcoming avoidance behaviour, safe sensory experience, and positive thinking, such as a tear collection jar, emotion badge, mood thermometer and emotion library. The scenario training follows a five-stage learning process: teaching, repetition, question-answer, memory retrieval [8], and ChatGPT instant dialogue [1]. The stories are developed by professionals, such as certified teachers, and reviewed by two experienced teachers. Each story takes around 10 minutes to complete.

2.2 Empirical Study

Study Design. As shown in Fig. 2, the study lasted 1.5 hours and followed a six-stage process. Students were required to complete a pre- / post-SDT [21] questionnaire with 12 equally weighted items, including behaviour (n=3; e.g., When interacting with *Loving Baby* and crafts, I participate in all learning activities), emotional (n=3; e.g., I find interacting with *Loving Baby* and crafts fun), cognitive engagement (n=3; e.g., I think of different ways to interact with *Loving Baby* and crafts), and intrinsic motivation (n=3; e.g., I am interested in interacting with *Loving Baby* and crafts). Each question followed a 5-point Likert scale, ranging from "Totally agree" (5 points) to "Totally disagree" (1 point).

Participant. We recruited 96 children (50 females: $\bar{M}$=8.96 years old, σ=.87 years old; 46 males: $\bar{M}$=9.00 years old, σ=.95 years old) from a local primary school in Tai Po (15-minute walk from the affected area), Hong Kong.

Inclusion Criteria. The participation criteria were (1) no medical or physical disabilities that could affect communication and handicraft skills, and (2) having prior knowledge of how to interact with tablets.

[2]ChatGPT 5: https://developers.openai.com/api/docs/models/gpt-5

Figure 3: The overview of classroom learning: (a & f) questionnaires, (b) students interacted with *Loving Baby*, (c) tailored clothes, (d) dressed up for, and (e) wrote heartfelt words for *Loving Baby*.

Regulation. Before having the experiment, we obtained informed consent from students and parents. Participation is fully voluntary. No compensation or remuneration is provided. The experimental protocol has received approval from the University Institutional Review Board (IRB).

As shown in Fig. 3, (a) students completed questionnaires at the beginning of the learning session. The class teachers read them the questions. Then, (b) students interacted with *Loving Baby*. This was a trial interaction (They will have a longitudinal interaction with *Loving Baby* for an half-year after this learning session). After that, students (c) tailored dressing with coloured pens and stickers for *Loving Baby* and (d) dressed up for it. Moreover, (e) they could write heartfelt words to *Loving Baby*. Finally, (f) students completed questionnaires at the end of the learning session. Their class teachers read them the questions again.

3 Efficacy

Questionnaire. We compared the impact of students' learning engagement and motivation after the interaction with *Loving Baby* using single-factor ANOVA. As illustrated in Table 1, behavioural (+12.7%, $p < .01$), emotional (+12.4%, $p < .01$), cognitive engagement (+12.22%, $p < .01$) and intrinsic motivation (+15.55%, $p < .05$) were statistically significant. Moreover, SDT demonstrated excellent internal consistency, with a Cronbach's α of .955. The results indicated that all variables provided highly reliable outcomes for three engagement and motivation variables. All variables showed strong positive correlations and consistency ($r \geq .78$).

Heartfelt words. The heartfelt words showed that students experience a range of emotions (e.g., happiness when helping others, sadness over blame, worry about bullying). They also took others' perspectives, inferring how *Loving Baby* might feel, and expressed care through imagined gifts and comfort. This combination of emotional labelling and perspective-taking suggests that the craft-and-robot context supported emotional awareness, prosocial intentions and emerging empathy, consistent with work on expressive writing and social-robot–supported socio-emotional learning.

4 Discussion

Emotional Expression, Empathy and Relatedness. Interacting with *Loving Baby* and the craft activity led to statistically significant gains in engagement and motivation. This indicated strengthened active participation and willingness to learn. This pattern accords with SDT, in which support for autonomy, competence and relatedness sustains engagement and intrinsic motivation [10]. The heartfelt words (e.g. "I am very happy as I can help others" and "I am very happy and joyful") reinforce this motivational effect. Students also used rich emotion vocabulary and perspective-taking (I think *Loving Baby* will be happy with my cloth"), suggesting emerging empathy towards peers and the robot, in line with prior findings on social-robot-supported socio-emotional engagement [16, 17].

Coherent SDT Engagement Construct. The questionnaire showed excellent internal consistency (Cronbach's $\alpha = .955$), and very strong correlations with three engagement and motivation ($r = .78$–$.88$). The results suggest that these dimensions formed a coherent engagement construct. This pattern is compatible with the idea that satisfying one basic need (e.g., relatedness through caring for *Loving Baby*) spills over into broader engagement and motivation [9]. Students' consistent references to make the robot laugh indicate that emotional connection and perceived competence were intertwined during the activity [18].

5 Conclusion and Future Works

This preliminary study shows that an AI-supported robotic companion with a craft workshop can significantly enhance engagement and motivation among primary students affected by the Wang Fuk Court fire. Quantitative feedback from coherent SDT-based scales suggests that the robot is experienced as a motivating teammate rather than a tool. Although limited to a single session and school, the work offers promising design directions for AI companions that jointly support learning engagement, emotions and well-being in post-disaster educational settings.

In future work, we will invite another group of students to establish a baseline comparison. We will also recruit students at different educational stages, including kindergarten, primary, and secondary school, to compare learning engagement and motivation levels. For

Table 1: The overview of single-factor ANOVA for questionnaire performance and correlation of each variable. ** and * denote $p < .01$ and $p < .05$. The acronyms BE, EE, CE, IM, and Imp stand for Behavioural, Emotional, Cognitive Engagement, Intrinsic Motivation, and Improvement, respectively.

		N	$\bar{x}$	σ	Imp	P-value	F-value	BE	EE	CE	IM
BE	Post	96	78.89	24.04	12.7	**	6.66	1	0.88	0.85	0.78
	Pre	96	70.00	23.69							
EE	Post	96	78.19	24.25	12.04	**	5.97		1	0.86	0.88
	Pre	96	69.79	23.37							
CE	Post	96	76.53	24.60	12.22	**	6.08			1	0.80
	Pre	96	68.19	22.17							
IM	Post	96	80.00	24.03	15.55	*	9.97				1
	Pre	96	69.24	23.20							

the six-month longitudinal data, we will perform a detailed thematic analysis and develop a data visualization dashboard to help teachers monitor student mental health.

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