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Exploring play experience with Japanese science, technology, engineering, and mathematics undergraduates in interactive art making: A qualitative study

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ABSTRACT

Higher education students in the science, technology, engineering, and mathematics (STEM) fields are actively engaged with coursework, and their emotional maturity may be underdeveloped. The aim of this qualitative study was to investigate whether interactive art-making can provide a potential space for STEM undergraduates to experience play and freely explore themselves. We introduced the mutual squiggle and story-making method (MSSM), an art-based method wherein a practitioner collaborates with a participant to create art, followed by semi-structured interviews. Thematic analysis of the interview transcripts from seven STEM undergraduates revealed four themes: personal joy and fulfillment, interaction as a pivotal aspect of play, acknowledging appropriate compromises, and a non-play experience. Our findings suggest that the potential space created by MSSM can help STEM students navigate play through picture-making and storytelling experiences. Practitioners who conduct art-making with clients should be aware that they are being observed by participants and exhibit playful attitudes. This study sheds light on lowering the barrier to seeking help among STEM students. Further studies involving different academic disciplines as target groups are required. Policymakers should be aware of the importance of positive emotions aroused in play for STEM undergraduates to seek psychological support.

The mental healthcare of students in science, technology, engineering, and mathematics (STEM) fields at higher education institutions has been gaining attention. STEM students face barriers to receiving help, including prejudice surrounding help-seeking behavior and negative attitudes about the usefulness of therapy. One of the key concepts for this age group is identity formation, which requires emotional development (Erikson, 1993). Emotional development provides individuals with the necessary foundation to navigate the complexities of identity formation. Art-based therapies have the potential to provide an environment for navigating through various emotional experiences and interactions, gradually developing the capacity to recognize, process, and regulate their emotions (Haysteen-Franklin et al., 2019). Creative and expressive arts therapy can provide a potentially non-stigmatizing and non-invasive approach, create a space for play experiences, and help STEM students' emotional development through mental healthcare (Smriti et al., 2022).

Owing to the increasing demand to resolve complex global human advancement concerns, countries are prioritizing human resource

development in STEM (Chen, 2009; Kersanszki & Nadai, 2020). Undergraduate and graduate students in STEM fields are typically in emerging adulthood; that is, during the age from 18 to 29 years (Arnett et al., 2014). For this age group, identity formation, which is to establish a coherent sense of self (Erikson, 1993), is a standard developmental task (Sugimura & Mizokami, 2012) associated with commitment and motivation in STEM (Perez et al., 2014). However, in Japan, low identity formation has been a risk factor associated with laboratory truancy among STEM undergraduate and graduate students (Kawanishi, 2017).

To establish a mature identity, the emotional development of STEM undergraduates is essential. Identity formation requires developing a positive and coherent self-image, curiosity about oneself and others, the ability to tolerate ambivalence and uncertainty, supportive relationships (friends and peers) and values. Unlike Western societies, where the emphasis is on young people becoming independent as individuals, Japanese culture emphasizes adapting to society and meeting the expectations of others (Sugimura & Mizokami, 2012). Therefore, for STEM undergraduates in Japan to develop a mature identity, fair emotional

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regulation, self-acceptance of strengths and weaknesses, playfulness, openness to new experiences and a willingness to examine contradictions are particularly necessary.

However, not only in Japan but also worldwide, STEM education includes conventions that can hinder their emotional development. For instance, students in STEM disciplines may often be denied opportunities to develop these traits due to cultural and academic expectations that reward achievement, maximalism and rigorous workloads. They are often required to spend more time on coursework than students in other disciplines (Jensen et al., 2023) at the expense of other social and relationship-building activities, leading to missed opportunities for them to experience and appreciate a diversity of emotions. Further, in a climate in which STEM educators reward and value ability and normative outcomes, students experience negative emotions (Wineinger, Fry, & Moore, 2022), hindering their emotional development. STEM fields are often highly competitive, with stern grades and performance evaluations, discouraging students from seeking counseling (Kalkbrenner & Miceli, 2022). These issues cause stress and frustration in STEM students in higher education. If such stress and frustration is not addressed properly, STEM students may develop anxiety, which inhibits their healthy emotional development.

Art-based methods can provide a safe space for STEM students to freely explore themselves, promoting their emotional development. Collaborative artmaking, which is non-competitive, non-verbal and requiring attunement to the other person, may provide experiences that help to improve the aforementioned skills (Rosen et al., 2016). Providing a supportive and collaborative atmosphere among individuals, who are members in laboratories and research groups, is essential for emotional development (Sugimura & Mizokami, 2012). As modern research is inseparable from collaboration and teamwork, excessive competition and maximalism will eventually hinder the ability of members of a laboratory or research group to be compassionate, empathetic, mutually respectful, and collaborative. These positive emotions are needed to broaden thought-action repertoires and enhance adaptive human functioning (Fredrickson, 2001).

Creative arts therapies (CATs) and co-creative art-making method

CATs and art therapy, involving a variety of art-based methods such as therapeutic art-making have grown in popularity. In Japan, art-based methods are used by art therapists, counselors, and other practitioners that provide psychological support; hence, the word "*therapist*" herein includes such practitioners. The material of CATs includes visual arts, music, dance, poetry, storytelling, drama, sandplay, and other creative processes to foster deep personal growth. (National Coalition of CATs Associations, n.d.; Japan CAT Association, n.d.). Although specialized training and credentials are required for effective use of art materials, the overarching target of CATs is the use of images, creativity, and metaphor as a guide to achieving good mental health and well-being. To date, systematic and scoping review studies of CATs have been growing (Abbing et al., 2018, 2023; Bosgraaf et al., 2020; de Witte et al., 2021; Dunphy et al., 2019; Feniger-Schaal & Orkibi, 2020; Frydman et al., 2022; Hertrampf & Warja, 2017; Schouten et al., 2015; Smriti et al., 2022; Van Lith, 2016). These studies show that CATs are used to alleviate psychological distress (Moss et al., 2022; Wilson, 2021) via emotion regulation (Haeyen et al., 2015; Koch et al., 2015), increase self-confidence, self-esteem, or self-efficacy (Kaimal & Ray, 2017; Kongkasuwan et al., 2016; Lange et al., 2018), and contribute to identity formation.

Various methods of CATs for the treatment of emerging adults have been studied widely (Smriti et al., 2022). However, the literature on interactional art-making procedures is mainly based on group art therapy, while studies on individual art therapy techniques are sparse (Rosen et al., 2016). With the increasing need of clients for visual art-making techniques from therapists, Nash (2020) summarizes various

techniques that include the therapist "working alongside" individual clients (Marshall-Tierney, 2014; Wadeson, 2003), therapists making art for their clients (Carr, 2014; Franklin, 2010), and Winnicott's squiggle game (Winnicott, 1984).

Winnicott's squiggle game can create a space for clients to communicate and share their emotions and projections with the therapist (Stefana & Gamba, 2018). It often serves as a defense against deep fears as a form of phantasizing activity (Günter, 2007) which involves the dynamic interplay between reality and fantasy, internal and external worlds, and the self and other (Nicolò, 2018). Eisdell (2005) identified the possibility of developing emotional vocabulary in clients by introducing a visual conversation, such as the squiggle game. By presenting them with a tangible form, individuals can more easily confront or distance themselves from their frustrations. For instance, by externalizing negative emotions and taking action through collaborative art, STEM students can learn to cope with the stress, tension, anxiety, and frustration caused by their coursework.

Winnicott's potential space and playing

The theoretical framework of interactive CATs involves Winnicott's concept of a potential space, which contrasts with "(a) the inner world (which is related to the psychosomatic partnership) and (b) with actual, or external, reality" (Winnicott, 1971, p. 55). In the potential space, internal fantasy and external reality intersect, facilitating self-formation. Here, fantasy refers to the creative and imaginative inner world of individuals where they can enact their desire in a way impossible within the constraints of reality. The potential space is created in the mother-infant dyad at the beginning of one's life, as a time and space for playing. In this potential space, individuals may experience a tension between feelings of omnipotence in their fantasies and frustration in real life (Winnicott, 1971). Through interactions with others who can witness, provide reassurance, and play together, new ways of experiencing oneself and others emerge (Nicolò, 2018). It is then that individuals develop a sense of self and navigate their emotional and social landscapes. This dynamic interplay between experience, fantasy, and self-formation occurs within the potential space, fostering growth and development. Although playing is an activity that begins with the mother-infant dyad, it extends to various aspects of human creativity and culture, including psychotherapy (Winnicott, 1971).

Experiences within the potential space, such as the squiggle game, can foster creativity and cultivate fundamental trust, essential for advancing identity formation in emerging adulthood (Erikson, 1994). The creation of the potential space is influenced by the personal traits of both the therapist and the client (Winnicott, 1971). Responsive art expression and therapist behavior during CATs lead to positive results, addressing the client's needs effectively (Bosgraaf, 2020). However, therapists must be aware of perceptual discrepancies between therapist and client and seek ways to convey imagery effectively to facilitate mutual non-verbal communication (Ito, 2010).

Mutual squiggle and story making: a playful participatory art-making method

A widely used therapist-participatory method in Japan is the Mutual Squiggle and Story Making (MSSM) developed by Japanese psychiatrist Yamanaka (2017). MSSM is an interactive technique involving both the therapist and the client and comprising picture- and story-making steps. In the picture-making step, the therapist draws a frame along the periphery of the paper and asks the client to divide the area into six to eight freely shaped compartments. Subsequently, in one compartment, the therapist draws a nonintentional line as a trigger line for the client's picture-making. Later, the client is asked to perceive something from the trigger line and complete the picture by drawing and coloring. When the picture is completed, the roles are reversed, and the client draws a trigger line in a different compartment, followed by the therapist's

picture-making. When all the compartments are filled with pictures, the client is asked to create a story using all the pictures. Through the story making, each image projected unconsciously is held together by the thread of consciousness to form a story (Yamanaka, 2017) to create an insightful meaning for the client.

In MSSM, the therapist plays the role of a mother and creates the potential space for the client, in which they can play freely. Here, we define *play*, according to Winnicott's potential space, as an experience in which individuals engage in both the intra-psycho and external environments, explore omnipotence in fantasy and frustration in reality, confront various emotions, and relinquish compulsion.

The collaborative efforts of the therapist and the client generate a visual representation, followed by the client's narrative creation, which both experience through shared exploration. Through these processes, the client and therapist can establish a potential space. Within the potential space, fantasy is enacted by the client, followed by the therapist's reflection of a playful attitude. Consequently, the client can release the frustration felt during playing and can develop positive emotions. The positive emotions aroused in the potential space will benefit undergraduate STEM students because the positive feelings felt during play can broaden thought-action repertoires and enhance adaptive human functioning (Fredrickson, 2001).

Several MSSM studies focus on developing relationships between clients and therapists (Tadaka, 2006) and communication with clients with poor verbal communication skills (Muraio, 2020; Tadaka, 2006). Studies also indicate the applicability of the MSSM technique to emerging adults, including university and college undergraduates (Satomi, 2011; Nagatomo, 2019). Through the assessment of the homogeneity of pictures by the interviewee, Satomi (2011) suggests that the color and touch of the pictures, as well as their use in story making, give an effective viewpoint to measure the relationship.

These findings suggest that the practice of MSSM may grant STEM students the opportunity to build supportive relationships with their counterparts and participate in emotional development activities. The potential space of the MSSM can help STEM undergraduates with unique and narrow communication patterns to explore themselves freely. However, no previous study has addressed the play experience of STEM undergraduates during MSSM. Further, previous studies have not been able to explore play experience from the clients' perspective, which is crucial for building an environment in which positive emotions can be elicited to broaden repertoires and build adaptive functioning (Fredrickson, 2001). Therefore, there remains a notable knowledge gap concerning the play experience of STEM undergraduates. Hence, there is a need for further investigation to fill this gap.

Current Study

Sutton-Smith (1997) argues that the objective stance of scientific research could have limitations because of science-embedded value systems; thus, exploring the source of ambiguity in play may be more fruitful. Considering this, empirical qualitative research on MSSM focusing on the clients' perception of the play experiences can provide insights into STEM undergraduates' emotional development. Hence, this study explored the play experiences of STEM students during MSSM to answer the following research question: "How do STEM undergraduates experience play in the potential space created in MSSM?" This study provides novel insights into how practitioners employing interactive art-making techniques can contribute to the development of STEM undergraduates.

Methodology

Research Design

We conducted MSSM to obtain pictures, stories, and semi-structured interviews. As MSSM was conducted as a playful art-making activity

rather than therapy, this study employed the word "researcher" or "counterpart" instead of "therapist." Among the various qualitative data, we only analyzed the interview data to investigate mutual communication. A qualitative approach was used to develop analytical themes and describe and explain social phenomena. A reflexive thematic analysis (Braun & Clarke, 2006; Clarke & Braun, 2013) was used to investigate play experiences among participating STEM undergraduates during MSSM. As participants had no prior experience with MSSM, the phenomenological worldview was also employed, involving double hermeneutics (Pope & Mays, 2020); that is, STEM undergraduates acknowledged their play experience and discussed it in their own words, which the researcher interpreted.

Ethical Considerations

This study was approved by the Ethics Committee of the Graduate School of Human Development and Environment at Kobe University (No. 591). Participants were informed through an explanation sheet that they could withdraw at any time, their contributions would eventually be published, and confidentiality would be maintained. All participants provided written informed consent.

Participants Recruitment

Data were collected between August and November 2022. Because play experiences may differ depending on the degree of identity formation among STEM undergraduates, we aimed to capture a maximum variety of experiences. Undergraduate students were recruited by distributing flyers across several classes. The flyers included a QR code to access a web-questionnaire form to measure the level of identity formation. We used the Multidimensional Ego Identity Scale (MEIS) (Tani, 2001), a 20-item Likert scale comprising four factors: Self-Sameness and Continuity; Self-Identity; Interpersonal Identity; and Psychosocial Identity. Ratings were obtained using a seven-point scale. Among the class attendees, 65 completed the questionnaire, and 13 agreed to participate by providing their email addresses. Although the MEIS consists of four factors, we used the total MEIS score for participant selection, which was calculated by summing all four factor scores. The mean and standard deviation (SD) of the total MEIS score for the 65 respondents was 87.5 and 20.8, respectively. We selected five students with the highest MEIS scores and five with the lowest MEIS scores and sent them emails inviting them to participate in the MSSM sessions. Three of them did not reply to our emails by the deadline. Therefore, seven undergraduate students with an average age of 19.4 (SD) = 2.14 participated in this study (n = 7). Although insufficient to represent all STEM students, we deemed it adequate to comprehend the experience of play through participants' individual frames of reference or worldviews, which was the primary objective of this study. Participants' information is summarized in Table 1.

Table 1
Participants' Characteristics.

Participants (Pseudonym)	Academic major	Age (years)	Sex	MEIS score	Level of Identity formation ^a
Atsuki	Engineering	18	Male	98	High
Bunto	Engineering	18	Male	105	High
Chiho	Science	18	Female	103	High
Dai	Science	19	Male	48	Low
Eito	Mathematics	24	Male	75	Low
Fuka	Interdisciplinary technology	20	Female	46	Low
Gina	Interdisciplinary technology	19	Female	52	Low

^a The level of identity formation was categorized based on the MEIS score (mean = 87.5, SD = 20.8); MEIS, Multidimensional Ego Identity Scale

Researchers

The researchers' positions are briefly described to acknowledge the possible presuppositions (Clarke & Braun, 2013). The first author is a middle-aged female clinical psychologist with a master's degree. With a bachelor's degree in physics, she is equipped to understand the perceptual tendencies of undergraduate STEM students. The second author is a clinical psychologist with prior experience as a counselor in Kosen, short for "Koto Senmon Gakko" in Japanese, a specialized technical college that offers a five-year education program focusing on STEM fields for students who have completed junior high school. The second author, with extensive research in art therapy, substantial experience in MSSM, and counseling experience with STEM students, supervised the first author to alleviate potential biases and presumptions and validated the emergent themes.

MSSM Procedure

The first author (the researcher) conducted all the MSSM and interview sessions as the counterpart for each participant in a private room with a large desk and chair to ensure privacy and workability, simulating the school counseling setting. The same room was used for all the participants. The researcher and participants were seated facing each other at 90 degrees across the corner of a desk. Each session lasted 50–90 min. A typical MSSM session was conducted as follows (an example of the typical procedure is shown in Fig. 1). First, the researcher explained, "Let us play a drawing game. It does not matter how good or bad you are at drawing, and there are no right or wrong answers; therefore, please take it easy." Second, the researcher drew a rectangular frame along the periphery of the white paper sheet. Third, participants were asked to divide the frame into six areas freely. Subsequently, the researcher drew a trigger line in an area and asked, "Please look at the line carefully. Do you see any images? Please add lines and colors to the paper to complete the image in this area." Upon completing the drawing, participants were asked to draw a trigger line in another area, and the researcher added lines and colors to complete the image, broadening the positive images and alleviating the negative images. This procedure was repeated until six images were acquired. Later, the story-making process began. Unlike Yamanaka's original method, wherein the client creates the story alone, this study adopted a method of alternate story creation between the participant and researcher, assuming that the interaction would promote the play. The researcher selected a picture and started

narrating a story, and participants developed the story using another picture. The story-making process was repeated until all the pictures were used. Finally, the participant concluded the story.

In the drawing phase, the researcher incorporated what she found interesting into participants' strategies, created pictures that would expand the story, and drew detailed pictures without being overly concerned with neatness. In the story creation phase, the researcher set the scene at the beginning to create the story flow while watching participants' responses. When the story was completed, a semi-structured interview was conducted following the interview guide (Table 2) to investigate how participants felt about the play. During the interview, the researcher openly disclosed her drawing and story-making strategies to create a safe space and encourage free expression. Table 3 presents selected quotes from the researcher's responses. The entire procedure was conducted five times per person, once per week. The artwork was scanned, and the stories and interviews were recorded. Thirty-five audio-recorded interviews were collected and transcribed verbatim by the first author. All the procedures were performed in Japanese.

Analysis Procedure

We followed the thematic analysis procedure (Braun & Clarke, 2006), which comprises several steps. First, by transcribing the audio recordings verbatim, the first author read the data, took notes, and familiarized herself with them. Consistent with the further phases of thematic analysis, the first author developed the initial codes. Subsequently, considering the research question, the codes were grouped into potential themes, and initial themes and subthemes were generated. Later, the first author reread the entire dataset to review and refine themes and subthemes and consulted the second author to determine

Table 2
Interview Guide.

Topic	Typical question
Overall impression	"How did you feel about your experience with the MSSM?"
Feeling of play	"Could you describe whether you felt a sense of play at any point during the process?"
Unexpectedness	"Were there any unexpected developments in the pictures or stories that emerged?"
Interaction	"How did you feel during the interaction?"
Reflection	"What were your reflections after reviewing the five sessions?"

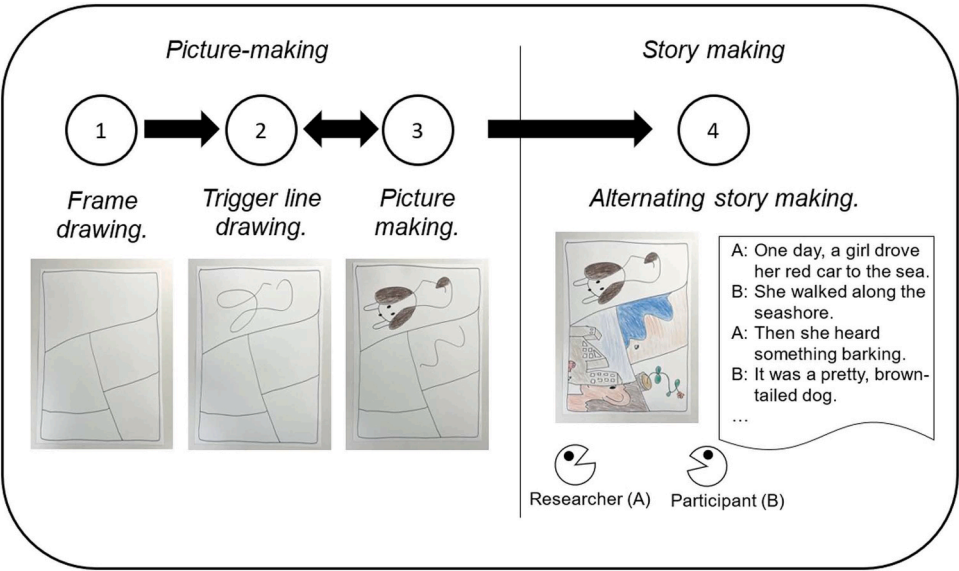


Fig. 1. Example of Typical Procedure of MSSM.

Table 3
Selected Quotes from the Researcher's Response.

Phase	Researcher's quote
Picture drawing	"I really wanted to turn this spinning thing into an electric coil. As I was drawing, I thought about measuring the electromotive force induced in the circuit, so I added a magnet bar here." "This time, I thought it might be cool to turn it into something specific, so I drew a Boa constrictor from 'The Little Prince,' which swallowed an elephant."
Story making	"Since you always have some unexpected twist at the end of your stories, I thought I would give it a shot, too."

whether these themes and subthemes represented the experience of play (or non-play). Finally, the first author redefined the themes to respond to the research question adequately. The emergent themes were as follows: enjoying joy and fulfillment, interaction as a pivotal aspect of play, acknowledging appropriate compromises, and a non-play experience. The content was translated into English by the first author and confirmed by the second author.

Findings

From the thematic analysis, four themes and 13 subthemes emerged (Table 4). The themes and subthemes were the same for both participants with low and high MEIS scores, with the exception of one subtheme.

Enjoying joy and fulfillment

STEM undergraduates felt their subjective awareness of play reflected in the quotation: "You allowed me a lot of freedom with things like this, so it feels like play, or rather, enjoying it on my own" (Fuka).

Three subthemes emerged. Under the subtheme of discovery of self through challenges, participants were playing inside their head and noticed a novel feeling, such as "I have never thought that I can create so many things from such a non-meaning line" (Bunto) and "It was fun to make up a story. It was difficult to decide what order to go in, so I just played around with it" (Atsuki). In the picture-drawing step, they often adjusted themselves to experience competence, as "I thought that I could do it with my skills" (Eito).

Under the subtheme of encouragement of free-flowing thinking, STEM undergraduates were inspired in their fantasy thoughts and sometimes depicted them individually, which might typically be considered unrealistic (Fig. 2, bottom left):

At first, I saw a face on this curved line, just as I usually do. But then I realized I could not use this part of the line if I wanted to draw it. So, I

Table 4
Themes and Subthemes.

Themes	Subthemes
Enjoying joy and fulfillment	Discovery of new self through challenges Encouragement of free-flowing thinking Voluntary enhancement and immersion in expression
Interaction as a pivotal aspect of play	Curiosity about how the counterpart will respond Surprise at the counterpart's approach Subtly expressing a desire for understanding Settling for an alternative notion
Acknowledging appropriate compromises	Relying on established thought patterns Handling with moderate informality Feeling unconvinced and frustrated
Non-play experience for participants	Encountering feelings of tension and anxiety Perceived lack of room for play Mere relaxation or tension relief

was inspired by this clover and thought I could turn it into a plant. It was not something I would normally do, but that was where the inspiration came from. However, this did not usually occur. Plants with parallel and reticulate veins cannot grow together in reality. (Dai)

However, these thoughts do not often emerge voluntarily. When the researcher asked the participant why he refrained from drawing a mouth when he drew an octopus (Fig. 3, bottom middle), he replied, "I thought it would be more childlike or babyish if I drew it without a mouth" (Eito). He intended to draw a baby octopus; an intention that might not have been discovered if the researcher had not inquired.

Under the subthemes of voluntary enhancement and immersion in expression, participants actively created, elaborated, and occasionally immersed themselves in expressing images during the MSSM. Some attempted to create and enjoy something new. Sometimes, coloring the pictures made them concentrate deeply: "I just kept on coloring... I wonder if I might have overdone it" (Bunto). Additionally, some undergraduates refrained from expressing their initial thoughts and illustrated what felt more appropriate to them through careful consideration.

In summary, MSSM helped STEM undergraduates discover new aspects of themselves, encouraged them to imagine themselves more expansively, and promoted the drawing of pictures with both elaborate and unconscious immersion. These results showed an authentic experience of the play.

Interaction as a pivotal aspect of play

By interacting with the researcher as their counterpart in MSSM, STEM undergraduates felt that the interaction was pivotal in their play experience: "I hadn't had much time to play with others, especially because I had been busy studying, so it was a lot of fun" (Chiho).

Three subthemes were identified. Under the subtheme of curiosity about how the counterpart will respond, they were inspired by the pictures: "When I saw this picture, I realized that I wanted to do it, too, and I think I was able to play with the colors quite a bit" (Fuka). They sometimes noticed their bias: "I had always taken it for granted that someone would do something for me, so... when I heard the cook asking them to peel chestnuts, I realized that ...there is such a way of thinking" (Gina). While conducting MSSM several times, they noticed and observed changes in the researcher's drawings: "I thought you were drawing the shape of hands firmly, but this picture was poorly drawn in some way, so I wondered why" (Bunto).

Under the subtheme of surprise at the counterpart's approach, the researcher's picture-drawing strategy surprised the STEM undergraduates: "After drawing this, I expected fewer lines, imagining it to take on a shape close to this. However, it turned out entirely different, surprising me" (Gina) and "Terrific, you've made up a picture using every bit of the lines" (Dai). Mutually created stories also surprised them:

If I were to write a story myself, I would probably have planned it beforehand. Then, I might lead to a story that is always the same, or maybe I get stuck in the same routine. But with a partner, I never know what kind of tale we will come up with or in what order the stories will unfold. So, it is really fun piecing everything together as we go and notice all the different perspectives. (Chiho)

Under the subtheme of subtly expressing a desire for understanding, participants expressed that they hoped their counterparts would understand what they had expressed. One participant spoke about her picture of a bird-shaped cookie (Fig. 4, top right).

I drew this picture to make it appear slightly softer. I felt like making sweets involved a lot of steps of mixing ingredients, so I wanted to convey the feeling of something being made in a factory with skilled confectioners by adding some circular elements to the surroundings. (Fuka)

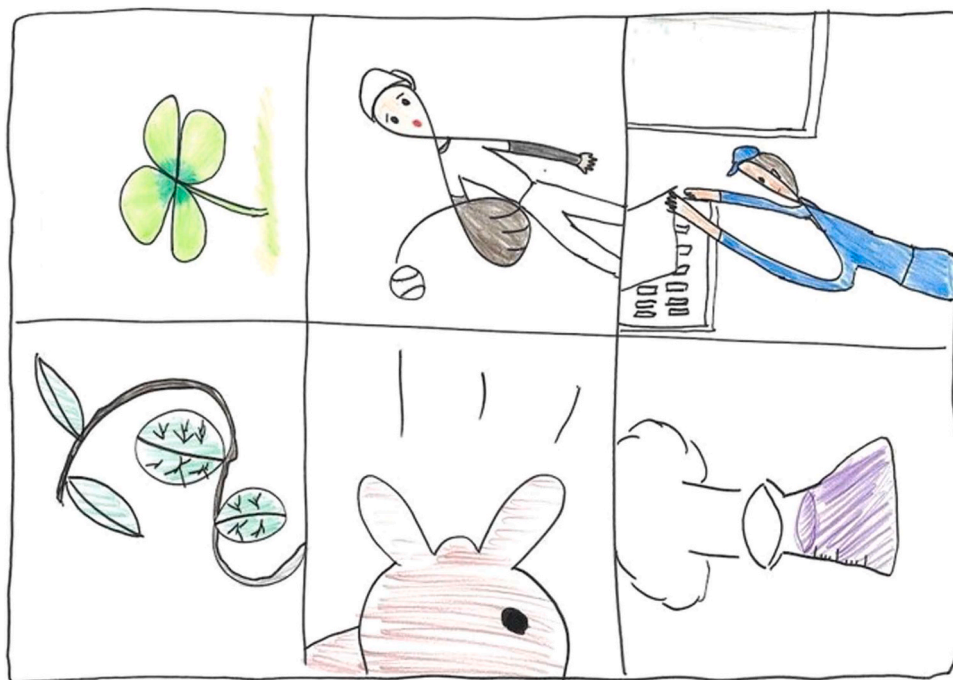


Fig. 2. Picture sheet of Dai and the researcher (#5).

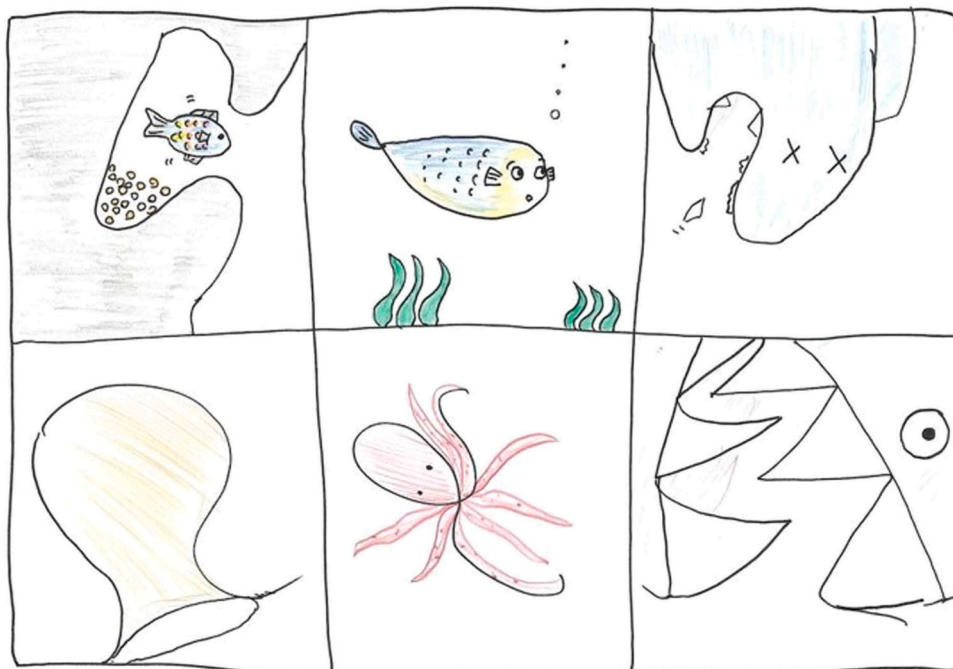


Fig. 3. Picture sheet of Eito and the researcher (#2).

Another participant explained that when he could relate to his existing knowledge, he consciously incorporated it thoughtfully into the story. When asked about his feelings on this approach, Eito hoped for his expression "to be comprehended." Despite not voluntarily initiating discussions about their expressions, they communicated their intentions when prompted by the researcher.

In summary, they observed the effects of happenstance. Because they had to collaborate with a counterpart, they could not predict the narrative or control the image sequence, helping them adopt an alternative perspective that enhanced their enjoyment of the experience.

Acknowledging appropriate compromises

Participants sometimes compromise in their interaction process during MSSM, deriving alternative thinking perspectives, escaping into patterns, or reducing commitment. Three subthemes fall under this category.

Under the subtheme of settling for an alternative notion, participants stated that although they imagined various images, they could not fully depict them: "It was difficult to draw. I thought too much about it, and then I thought, I will draw something simple, something that can be

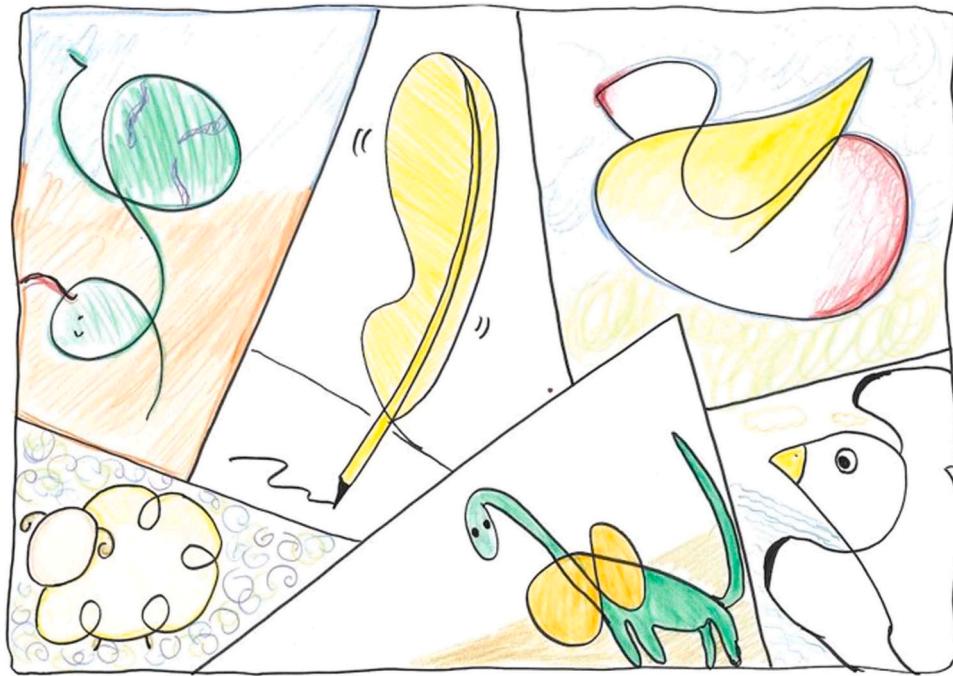


Fig. 4. Picture sheet of Fuka and the researcher (#1).

connected to anything" (Bunto). They reduced their commitment to drawing, as shown in the following quotation about a picture (Fig. 5, bottom middle):

I was thinking of drawing a fruit plant, but I realized that there were already two plants. However, I thought that having three might make the story more interesting, so I kept drawing. At first, I thought about turning them into figs, but I wondered if they would grow into such large numbers. It seemed a bit different, but anyway, cherry tomatoes should do, so I went with them. (Atsuki)

They had to create another way of thinking when encountering

circumstances outside of their imagination during the story-making process:

At first, I was planning to end up with a scene of the experiment using the oscilloscope, but the scene had already been used, so I thought it would be nice if they could go out to eat macarons or shaved ice at the end. (Gina)

As indicated in the quote, because the researcher had already used the image depicting the scientific experiment, Gina had to compromise by opting for another setting to render the story plausible, evoking her sense of play.

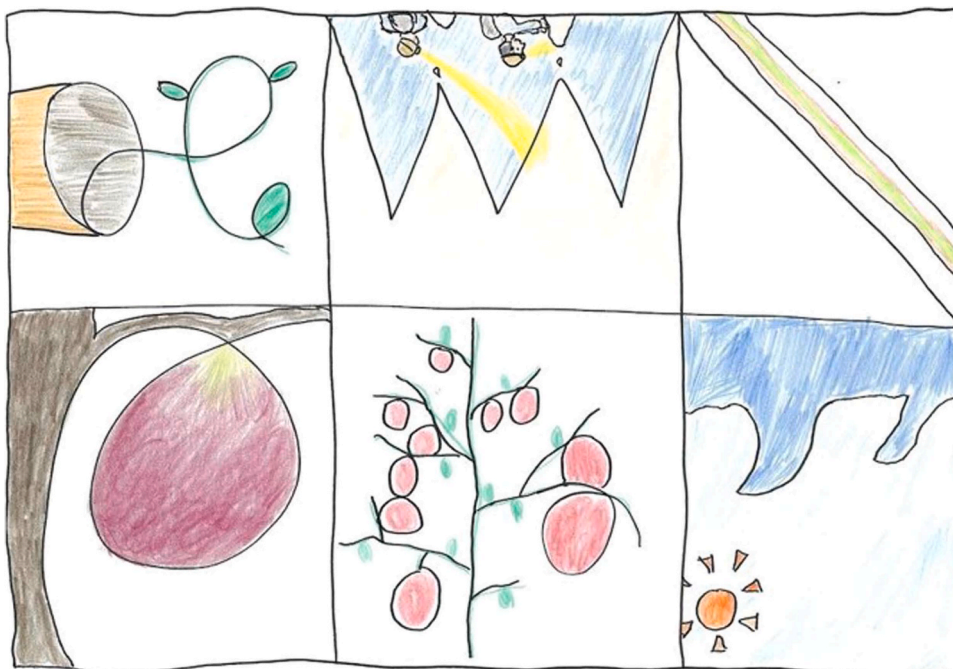


Fig. 5. Picture sheet of Atsuki and the researcher (#4).

Under the subtheme of relying on established thought patterns, participants reluctantly escaped into patterns when they could only think of a limited image: "Well, it just seemed like a mountain. I tried to find something different, but it did not work well" (Dai). They noticed their tendency, as shown in the following quote: "When an image to draw came up, I could only see it that way. I found that I could come up with only one image. If I came back to this line again, I would draw the same picture as this one" (Fuka).

Under the subtheme of handling with moderate informality, STEM undergraduates reduced their commitment and handled the situation somewhat casually: "I thought it would be more beautiful if butterflies came out of the mouth. It was just a story, so I thought it would be okay to make it up as I went along" (Bunto). A participant stated that when she drew a trigger line, "it looked like an ω , so I added more curves and made the shapes of the alphabets, I and V" (Fuka). Considering that the Greek letter ω usually represents the angular frequency in electromagnetics and her facial expression while talking, Fuka drew "I" and "V," representing current and voltage, respectively, somewhat frivolously.

In summary, STEM undergraduates fostered play-friendly environments by exploring alternative ideas, withdrawing from challenges, escaping familiar thought patterns, and approaching situations with a somewhat carefree and makeshift attitude.

Non-play experience for participants

There were instances when the STEM undergraduates were not in play during MSSM. They sometimes felt frustrated and uneasy and felt they were performing a task. Four subthemes emerged.

Under the subtheme of feeling unconvinced and frustrated, some noticed that their thought pattern was limited: "I cannot help but think in very scientific ways. Well, it might be a matter of flexibility; I need to be flexible. I think it is okay because it is just a picture, just a picture, but..." (Chiho). In this quote, Chiho expresses her frustration. For some participants, repetitive MSSM made them feel a non-play experience:

Well, last time, I did not think I was going to make a story, so I did not think anything of it even though I had a lot of characters, but this time, I had that, so even if I had an idea, I would have thought, hmmm, or something like that, so I guess I was not as honest as I could have been. (Fuka)

Under the subtheme of encountering feelings of tension and anxiety, a participant shared: "I am not very good at being asked to do something freely" (Gina). This subtheme emerged only from the participants with low MEIS scores. In the one-on-one setting of the MSSM, she felt a compulsive urge to complete tasks. Under the subtheme of perceived lack of room for play, they stated that sometimes they felt that tackling picture-drawing and story-making was work-like tasks, as shown in the quote, "Not like playing with it, but more like working with my mind" (Eito). Under the subtheme of mere relaxation or tension relief, negative feelings were reduced, as shown in the quote, "I didn't have to worry about whether it was the right thing to do" (Fuka) and "Well, I didn't feel like I had to do, had to do, so...I don't know why, but I enjoyed it" (Gina).

However, they also noted that their experiences could not be categorized as play. Hence, sometimes, participants felt unconvinced and frustrated, experienced feelings of tension and anxiety, and perceived a lack of room to play. While sometimes experiencing relaxation or relief from tension, these emotions alone do not qualify as play.

Discussion

We identified four themes and 13 subthemes concerning STEM undergraduates' play experiences in the potential space created in the MSSM. Although this was sometimes a non-play experience, STEM undergraduates often enjoyed fulfilling and engaging interactions with their counterparts and sometimes compromised to create margins for

play. We gathered data from both participants with low and high MEIS scores. Comparing the two, while only low MEIS participants stated that they experience tension and anxiety before conducting MSSM, the other themes and subthemes were equally emerged from both kinds of participants.

Notably, STEM undergraduates perceived interaction with the researcher as a pivotal aspect of play. While engaging in MSSM, they likely understood that the picture quality and the correctness of narrative trajectories were not of the utmost importance. As they understood the main aim of the play, they were able to freely create artwork from their own perceptions. Teoli (2020) reported that art therapists' art-making affects clients by increasing participation, trust, and empowerment. Kurimoto et al. (2021) reported that through visual art activities, such as drawing and modeling, awareness of the art activities difficulty diminished, prompting emotional stability. Our findings align with these studies. During MSSM, when the researcher adopts a playful attitude, STEM undergraduates can engage in unknown "play" by employing creative strategies during picture-drawing or story-making processes. This fosters co-creation between participants and their counterparts.

Further, STEM undergraduates observe how their counterparts change the trigger lines and initiate or develop the storyline without judging the aesthetic appeal or quality of the narrative. Throughout the MSSM, the STEM undergraduates anticipated what would come next and closely observed the researcher, often discovering that their experiences differed from their expectations. Such experiences could encompass what Sutton-Smith (1997) referred to as the rhetoric of fate, influenced by happenstance and frivolity, resulting from counterparts' playful attitudes. Hence, STEM undergraduates cultivated a relaxed and casual attitude toward appreciation.

Notably, STEM undergraduates participating in MSSM and feeling a non-play experience often reduced their involvement by compromising or viewing the situation from a detached perspective. For the participants, play might have been defined as an activity that can elicit positive emotions (Nakano, 2019). However, although they perceived this experience as "non-play," this shift seemed to alleviate the constraints associated with drawing and the emphasis on correctness, allowing them to enjoy playing a game. Salen and Zimmerman (2003) state that in designing a game, the "space of possibility" appears "where your players will explore and cavort, compete and cooperate, as they travel through the experience of playing your game." The concept of "space of possibility" symbolizes Winnicott's potential space, an intermediate, creative, and dynamic psychological realm that fosters exploration of the self and the world through transitional experiences.

This aspect of gameplay is also supported by Kriss (2016), who argues that video games are a kind of potential space that can spark therapeutic change. Video games are characterized by settings, characters, and the gaming system in which non-player characters face the gameplayer in the game space, providing the illusion of the other existing in the game space (Kriss, 2016). In the settings within video games, Kriss (2016) argues that when the client is a gameplayer, the other who shares the potential space can be the non-player character.

However, the non-player character is not the one who can sense the client-player's need. As Ito (2010) suggested, a responsive attitude from the therapist is necessary to facilitate mutual communication. When the video game fails to provide the tether that bridges the physical and virtual worlds, the generation of potential space will be inhibited. Contrastingly, the entire MSSM process acted as an art-making game for STEM undergraduates, with both participants and their counterparts having a playful attitude. The video game is performed in a virtual space in which the client-player's experience is less tangible compared with a real experience such as MSSM. However, in MSSM, practitioners, while maintaining a playful attitude, can ensure their respect for participants and their artwork to discover more about their needs and assets (Cassina et al., 2022). The fundamental trust maintained by such underlying respect leads to a co-creative, mutually appreciative, and playful

relationship that fosters clients' development. Engaging in these transitional experiences is crucial for healthy emotional development and the formation of a robust sense of self (Winnicott, 1971). Emotional well-being and the establishment of a firm sense of self are key to the identity maturation process.

Strengths and limitations

Given the paucity of the literature, this study adds valuable insights on individual art therapy techniques to interactive art-based research. Moreover, this study is innovative in exploring effective support measures using the MSSM for STEM students in Japan. This supplements the relatively limited literature on non-Western cultures despite the growing global demand for human resource development. The key strength of this study is that it offers some insights into lowering the barrier to seeking help in STEM undergraduates by focusing on the play experience using an interactive art-making method. The study's perspective advocates for providing psychological support, emphasizing the promotion of health rather than solely addressing diseases among STEM students in higher education.

A limitation of this study is that it included only STEM undergraduates and had few participants. Hence, the findings may have limited generalizability. Therefore, future studies should involve different academic disciplines as target groups to expand the current findings. Additionally, the effect of the MSSM on STEM students' identities were not assessed. Consequently, more data should be collected to uncover dissimilarities in play experience among STEM students with low and high identity formation. Moreover, investigating the collected pictures and stories in detail from the viewpoint of, for example, Developmental Transformations art therapy (Rosen et al., 2016), may contribute to evaluating the effect of the MSSM on identity development among STEM students. Specifically, tracking participants' psychological processes over time allows researchers to identify patterns of change, factors that contribute to therapy success or challenges, and inform evidence-based practices.

Conclusion

The MSSM can create a potential space for play wherein STEM undergraduates feel safe to enact their fantasies, feel frustrated when faced with difficulty in making images, and release their frustration by compromising with the help of their counterparts. STEM undergraduates also perceived the MSSM process as a game of art-making because their counterparts exhibited a playful and reactive demeanor. Practitioners of art-based methods, particularly those who engage in interactive art-making like MSSM with clients, should be mindful that they are under observation by participants and need to actively participate in the art-making process, exhibiting emotional responsiveness that is key to the success of the session. Future studies are required to investigate the effects of the MSSM on identity formation and to investigate groups from other academic disciplines. Policymakers should be aware of the importance of positive emotions aroused in play for STEM undergraduates as these can be used to encourage them to seek psychological support.

Ethics

This study was approved by the Human Ethics Committee of the Graduate School of Human Development and Environment of Kobe University (No. 591–3). All the participants provided written informed consent.

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CRedit authorship contribution statement

Tetsuko Kato: Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Toshiki Ito:** Writing – review & editing, Validation, Supervision, Project administration.

Declaration of Competing Interest

There are no conflicts of interest to declare.

Data availability

The data that has been used is confidential.

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