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EXPLORING SCIENCE EDUCATION THROUGH TOYS AND HANDS-ON ACTIVITIES: PARTICIPANT INSIGHTS

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Abstract: A two-day international ICASE workshop on exploring science education through toys and hands-on activities was held in a demonstration school in Southern Province, Thailand. The workshop objectives were to 1) create awareness of the use of toys and hands-on activities to teach science education and 2) to expose the students to the science toys and hands-on activities in learning science in the classroom. Amongst the 168 international and local delegates who participated in the workshop, we only focused on the 132 secondary students (aged 13 to 18) from the demonstration school as our study participants. A four open-ended questionnaire was administered to the study participants the week after the conference to gauge the students' feedback on the international ICASE workshop. A total of 113 completed and returned the questionnaires (85% response rate). Findings revealed that students responded positively towards the ICASE international workshop. The participants enjoyed the science show, science toys, cock fighting games, Mr. Wolf and Food UNO card games. Based on the positive feedback, future international workshops in science education can be organized to further expose and encourage the students to learn science through toys and hands-on activities.

Keywords: interactive science toys, hands-on activities, science workshop
Field: Education

1. INTRODUCTION

Science teaching should be interactive, enjoyable, and hands-on. Several studies in Turkey have presented similar results. Teachers who teach science in a fun and playful manner may spark students' interest in the subject (Bulunuz, 2012a, 2012b; Jarret, 1998, 1999). Teacher's empathy and classroom climate may significantly impact students' attitudes towards the subject (Miljenovic, Travar & Opsenica, 2024). When students are free to play and experiment with materials, they show curiosity, creativity, and initiative (Jarret & Jafri, 2019). Students who received play-oriented science instruction outperformed those who got textbook instruction in terms of science test scores (Jarret & Jafri, 2019). Hands-on activities in the classroom have been shown to have a positive motivational effect while teaching science in both the USA and Turkey, according to studies (Bulunuz & Jarrett, 2015). According to one study done in a 7th grade elementary school, 96% of students who participated in fun, hands-on science (SCIIS) took up more science courses in middle school, while just 4% of students who only learned science from textbooks did so (Sprague & Wolf, 1983). While doing hands-on activities such as games, students learn a wide range of social skills like sharing, negotiation, strategizing and taking turns (DeVries, 2016).

Teaching science with toys can be highly motivating for teachers as well as the students (Jarrett et al., 2020). In 2013, the Secondary Science Department of the Institute for the Promotion of Teaching Science and Technology (IPST) tested the Science of Toys textbook with a group of teachers and students in the 7th to 9th grades in the secondary schools in Thailand. Findings from the study indicated that both teachers and students liked the content, learning activities and teaching approach with science toys. Students reported that learning science with toys was engaging and had helped them better understand the scientific concepts (Jarret & Jafri, 2019; Thananuwong, 2015). Toys are tools of play and have meaning across the life space (Erikson, 1997) and culture (Sutto-Smith, 1986). A study conducted in Nigeria suggested that traditional Igbo games and play activities helped students learn basic scientific concepts and process skills (Okeke, 1984). Students also displayed positive scientific behaviour such as curiosity, critical reflection and objectivity (Okeke, 1984). As the students learn through play, they can also engage in measurement and scientific or engineering design (Jarret et al., 2020).

As students develop concepts through play, play can foster a lifelong interest in science education

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(Bulunuz & Jarrett, 2015; Csikszentmihalyi & Bennet, 1097; Jarrett & Jafri, 2019; Onder, 2018). Findings in the Games Project in the USA reported games had effectively fulfilled the instructional goals and simultaneously piqued students' interest in learning science (Lowe, 1988). Games give students the same opportunity to learn about their own cultures as traditional scientific toys do. Students may be able to arrange meaningful learning experiences through games and activities (DeVries & Edwards, 1973). As a result, toys, games, and activities have value for teachers as well.

2. MATERIALS AND METHODS

A two-day international ICASE (International Council of Associations for Science Education) workshop on teaching science using toys and hands-on activities was held in a demonstration school in Southern Province, Thailand. The international ICASE workshop has two objectives: 1) to create awareness of the use of toys and hands-on activities to teach science education and 2) to expose the students to the teaching of science education using toys and hands-on activities. Our research study was guided by two research questions:

1) What is the participants' feedback on the international ICASE workshop on teaching science using toys and hands-on activities?

2) What can be inferred from the participants' feedback on the international ICASE workshop on teaching science using toys and hands-on activities?

We limited our study to 132 secondary students (ages 13 to 18) from the demonstration school out of the 168 local and international delegates who attended the workshop. Secondary school students from the Southern Province of Thailand's demonstration school participated in the study. Mathayom is the name of the secondary division in Thai schools. Students in grades 13 through 15 attended Mathayom 1 through 3. Students ages 16 to 18 who are enrolled in Mathayom 4–6 make up the higher secondary school. For the students in Matahyom 5 (M5), attendance was required. For the Mathayom 1 (M1), Mathayom 2 (M2), and Mathayom 4 (M4) students, it was optional. There are currently no Mathayom 3 (M3) pupils enrolled in the school.

Through official email, the organizer invited science education specialists from Thailand, Malaysia, Taiwan, and India. Four science teachers from secondary schools and a STEM coordinator from several regions in Thailand were among the other workshop presenters. Additionally, three groups of secondary school students from Thai schools in the southern provinces gave presentations of their work. A leaflet outlining the goal, time, location, and expense was sent by email by the organizer to the schools. After responding via email or the official LINE of the organizer, interested parties were given a presentation time and notified of their allocation. We excluded delegates not from the demonstration school (n = 36) from the 168 participants since we were primarily interested in only the students (n = 132) who attended the demonstration school in the Southern Province. Since there were fewer than five participants in the study, M2 students were not included.

3. RESULTS

Descriptive analysis was used to analyze the data.

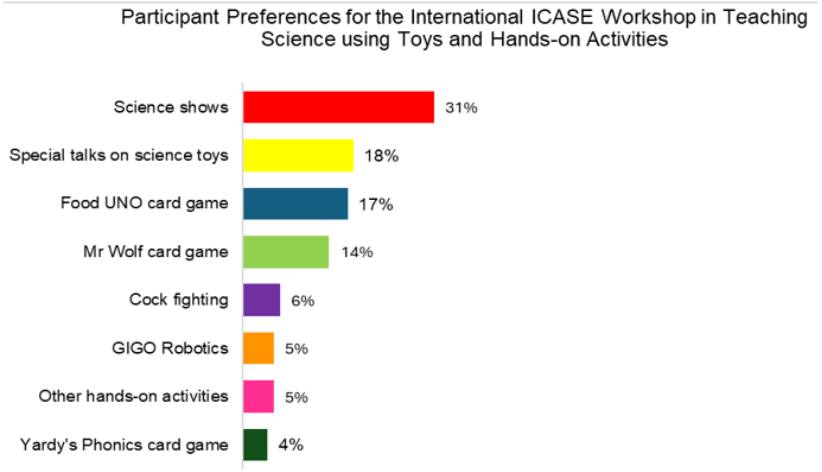
Table 1. Number of participants, respondents and response rate for the ICASE Conference

	Participants (n)	Number of responses (n)	Respond rate (%)
M1	34	34	100
M4	40	35	81
M5	58	44	76
Total	132	113	

Source: Ong, Yingprayoon, Ong (2024)

A total of 113 participants completed and returned the questionnaires, representing an 85% response rate (Table 1). Approximately half of the respondents (n = 58, 44%) (M5 students) attended the conference as presenters, while 74 (56%) attended voluntarily. Amongst the M4 and M5 participants, 13 (10%) served as student helpers. Two students role-played as the masters of ceremony and workshop facilitators while other students acted as photographers and also workshop facilitators. Over the 2-day duration of the international ICASE workshop, 121 (91.6%) respondents attended 85-90% of all the sessions on the first day. 80 (60%) respondents attended 70-80% of the sessions on the second day, and 64 respondents attended more than 40% of the sessions.

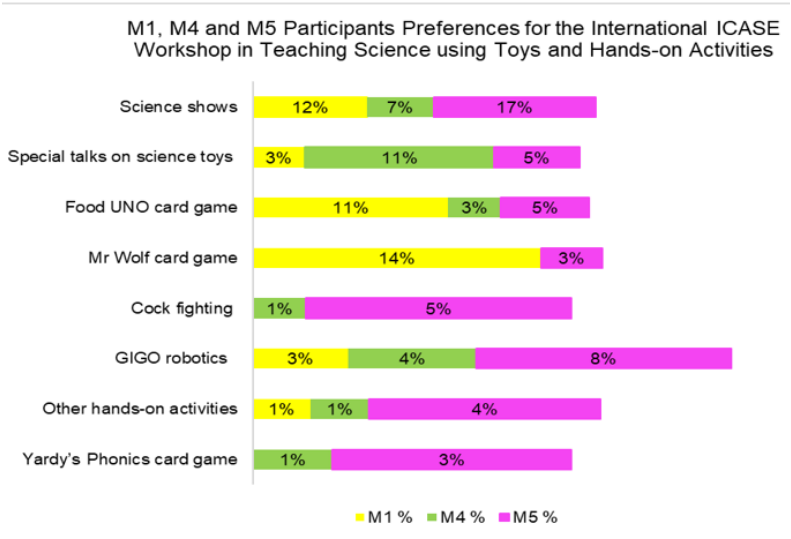
Fig.1. Participants' preferences for the international ICASE workshop in teaching science using toys and hands-on activities



Source: The authors

Figure 1 represents participant preferences for the international ICASE workshops in teaching science using toys and hands-on activities. 31% (n = 43) favoured the science shows. Participant preferences for the special talks on science toys, Food UNO and Mr. Wolf card games were somewhat similar with 18% (n = 23), 17% (n = 22) and 14% (n = 18) respectively. Participant preferences for the other workshops were somewhat evenly distributed amongst the cock fighting workshops (n = 8, 6%), GIGO robotics (n = 7, 7%), other hands-on activities (n = 7, 7%) and Yardy's Phonics card game (n = 5, 4%).

Fig. 2. M1, M4 and M5 participants' preferences for the international ICASE workshop in teaching science using toys and hands-on activities



Source: The authors

Figure 2 shows the breakdown of M1, M4 and M5 participants' preferences for the workshops they liked best at the international ICASE workshop in teaching science using toys and hands-on activities. M5 participants favoured the science shows (17%) and GIGO robots (8%), with their least favourite activities being the cards games (Food UNO card game, 5%; Mr Wolf card game, 3% and Yardy's phonics card game, 3%). In contrast, the M1 students enjoyed the Food UNO (11%) and Mr Wolf card games (14%) very much. M4 participants preferred the special talks on science toys the most (11%).

Table 2. Respondents' workshop preferences and their preference reasons

		M1	M4	M5	Total
Workshops	Reasons	Number of respondents (%)			
Science shows	It was fun.	10(33.3)	10(33.3)	12(40)	30(56.6)
53	Learnt physics principles.	10(43.5)	4(17.4)	9(39.1)	23(43.4)
Special talks on science toys	Learnt new science principles.	12(30.7)	17(43.6)	10(25.7)	39(59)
66	Learnt about science toys.	10(37)	11(40.7)	6(22.3)	27(41)
Food UNO card game	It was fun.	12(46.3)	6(23)	8(30.7)	26(59)
44	Learnt new vocabulary.	3(37.5)	4(50)	1(12.5)	8(18.3)
	Made new friends.	3(60)	1(20)	1(20)	5(11.3)
	Learnt to strategize how to win.	2(66.6)	1(33.4)	0(0)	3(6.8)
	Loved to play card games.	0(0)	1(50)	1(50)	2(4.6)
Mr. Wolf card game	It was fun.	11(57.9)	6(31.6)	2(10.5)	19(48.7)
39	Learnt to tell the time.	1(14.3)	5(71.4)	1(14.3)	7(18)
	Taught others to tell the time.	0(0)	3(75)	1(25)	4(10.3)
	Made new friends.	3(42.9)	3(42.9)	1(14.2)	7(18)
	Learnt to strategize to win.	0(0)	1(50)	1(50)	2(5)
Cock fighting	It was fun.	4(20)	6(30)	10(50)	20(86.9)
23	Learnt physics principles.	0(0)	0(0)	2(100)	2(8.7)
	Was my childhood game.	0(0)	0(0)	1(100)	1(4.4)
GIGO robotics	It was fun.	1(8.3)	4(33.3)	7(58.4)	12(60)
20	Used my imagination to make a toy.	0(0)	5(62.5)	3(37.5)	8(40)
Other hands-on activities	It was fun.	5(35.7)	2(14.3)	7(50)	14(53.8)
26	Learnt to make simple experiments.	2(22.3)	4(44.4)	3(33.3)	9(34.6)
	Learnt physics principles.	0(0)	0(0)	5(100)	5(19.2)
Yardy's Phonics card game	Learnt new vocabulary.	1(9)	4(36.5)	6(54.5)	11(55)
20	Learnt to practice phonics.	1(11.1)	3(33.3)	5(55.5)	9(45)

Source: The authors

Table 2 shows respondents' workshop preferences and their preference reasons. The respondents liked the special talks on science toys best because they could learn new science principles and science toys (n = 66, 59%). They also enjoyed the science shows very much because they were fun (n = 53, 56.6%), and they could learn physics principles (n = 23, 43.4%). A vast majority of the respondents (n = 44, 59%) agreed that the Food UNO card game was the most enjoyable as it was fun; they could learn new vocabulary, strategize and make new friends. Most respondents (n = 39, 48.7%) liked the Mr. Wolf card game since it was fun. They could also learn to tell the time and teach others to tell it in English. In addition, they learnt to strategize to win the game and made new friends. Meanwhile, almost half of the respondents (n = 23) agreed that cock fighting and other hands-on activities (n = 20) were fun. They could learn to make simple experiments and also learn physics principles. As for GIGO robotics and Yardy's phonics card game, the same number of respondents (n = 20) agreed that it was fun; they could use their imagination to make a toy, learn new vocabulary and practice phonics.

4. DISCUSSIONS

According to our research, the international ICASE workshop on teaching science through toys and interactive activities was well-received by the attendees. However, we did find some variations in the choices and preferences of the M1, M4, and M5 respondents. First, M4 and M5 respondents expressed more satisfaction with the science exhibitions and special discussions on science toys, compared to the gaming workshops. This result suggests that respondents from upper secondary schools are more knowledge-oriented since they are eager to learn about novel ideas in physics and science. Some M1 respondents gave specific explanations for why they preferred science shows and in-depth discussions on science toys, just like the M4 and M5 respondents did. This result is in line with studies that show teaching methods affect students' interest in the science (Bulunuz, 2012a, 2012b; Jarret, 1998, 1999). These findings have real-world applications; in addition to being enjoyable, teachers should help students better understand science concepts and ideas. Developing teachers' professional skills in science education is crucial (Radivojevic & Gavric, 2023; Tancic & Dermanov, 2023). For future international ICASE workshop, science teachers can create basic scientific worksheets and booklets. In the classroom following the worldwide ICASE workshop, teachers can further explain and mentor students on the pertinent subjects.

Second, lower secondary respondents (M1) were more attracted to game-oriented workshops. Similar findings were observed where younger students showed interest in learning science when

they were permitted to play and experiment (Bulunuz, 2012a, 2012b; Jarrett, 1998, 1999; Ong, & et al., 2020; Ong, Aslam & Amjad, 2024). In this regard, classroom science lessons should offer students more opportunities to play and engage with the materials (Jarret & Jafri, 2019; Atanasova, 2024). Our study found that younger M1 respondents preferred card games, whereas older M4 and M5 respondents favored hands-on science activities. This suggests a preference among younger students for learning science through enjoyable card games, while older students gravitated towards games and science toys reminiscent of their childhood activities. As previously reported (DeVries & Edwards, 1973), traditional games and science toys can evoke cultural memories. Additionally, M4 and M5 respondents preferred constructive hands-on science activities similar to findings in recent studies that found students can learn through play while engaging in measurement and scientific or engineering design (Jarret et al., 2020).

The study's limitations include its single-site focus on participants from one demonstration school, excluding others from different schools and provinces. A multi-site study is needed to improve the generalizability of the findings. Additionally, not accounting for respondent demographics such as age, gender, science knowledge, background, and interest in science may limit the depth and accuracy of feedback. Furthermore, the exclusion of teacher respondents prevents valuable insights into the international ICASE workshop on teaching science through toys and hands-on activities. Future research should incorporate surveys and interviews with teachers to enrich understanding of participant experiences.

5. CONCLUSIONS

Participants had positive experiences with the international ICASE workshop on teaching science using toys and hands-on activities. Students became motivated to learn science. They wanted to know more about the science activities and science toys from different parts of the world. It is suggested that more international ICASE workshops should be considered to further expose the participants to the trends, teaching and learning of science.

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