

Game-Based Learning in Action: Exploring Students' Engagement and Perceived Learning through SKUNK Probability

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ABSTRACT

Probability remains one of the most challenging topics for students in mathematics and statistics, often perceived as abstract, formula-driven, and disconnected from real-life applications. This study introduces SKUNK Probability, an adaptation of the classic dice game SKUNK, as a game-based learning (GBL) activity designed to explore students' engagement, motivation, and perceived understanding of probability concepts among diploma students. The research was conducted in introductory statistics courses at Universiti Teknologi MARA (UiTM) Tapah Campus, Perak, Malaysia. Students participated in the SKUNK Probability game, which integrates risk-taking, decision-making, and chance into an interactive learning experience. The learning activity was structured around Kolb's experiential learning cycle, with gameplay (concrete experience), reflective discussions, and follow-up questions used to connect students' gameplay experiences with formal probability concepts such as sample space, possible outcomes, probability of events, and experimental and theoretical probability. Data were collected using a post-activity feedback questionnaire and analysed using descriptive statistics. Findings showed highly positive student perceptions: 100% of students rated the activity as either enjoyable or very enjoyable, 97.6% agreed or strongly agreed that the activity helped them understand probability concepts better, and 95.2% agreed that the game helped them connect abstract concepts with real-life decision-making situations. Furthermore, 93.0% of students agreed or strongly agreed that they felt more motivated to learn probability following the SKUNK activity. The reflective discussions and reinforcement activities were incorporated to help students connect their gameplay experiences with formal probability concepts. Overall, the findings suggest that SKUNK Probability is a low-cost pedagogical activity with potential for wider classroom implementation. By bridging experiential and constructivist learning theories with engaging classroom practice, the activity offers educators a practical, student-centred strategy for teaching probability and providing students with an engaging and meaningful learning experience in probability education.

Keywords: Game-Based Learning (GBL), Experiential Learning, Student Engagement, Probability Education, Active Learning.

INTRODUCTION

Probability constitutes a fundamental component of mathematics and statistics, equipping learners with essential skills for reasoning under uncertainty, evaluating risk, and making informed decisions in fields such as engineering, economics, data science, and the social sciences. Despite its importance, many diploma-level students perceive probability as abstract, conceptually challenging, and disconnected from real-life applications. These difficulties may be influenced by prior learning experiences in which probability is often approached through procedural exercises and formula-based calculations. While such approaches can support computational proficiency, they may provide limited opportunities for students to develop deeper conceptual understanding and apply probability in meaningful contexts. Consequently, students may experience persistent misconceptions and reduced motivation towards learning probability.

Conventional lecture-based teaching methods, while effective for demonstrating procedures, may provide limited opportunities for active cognitive engagement and meaningful understanding of probabilistic ideas. In contrast, Game-Based Learning (GBL) has emerged as a promising pedagogical approach. By embedding learning within interactive and context-rich environments, GBL can support students' motivation, engagement, and conceptual understanding. In the context of probability education, a systematic review by Sharma et al. (2021) examined research on the use of games for teaching and learning probability and highlighted the potential of game-based approaches to support students' probabilistic thinking. Broader evidence from digital game-based learning further supports these findings. A meta-analysis by Barz et al. (2024), based on studies published between 2015 and 2020, found medium positive effects on overall learning and cognitive learning outcomes, a small positive effect on affective-motivational outcomes, and no significant effect on metacognitive learning outcomes. Beyond these overall benefits, the nature of students' engagement during gameplay is also important. Moon and Ke (2020) found that specific in-game actions promoted content and cognitive engagement, which were associated with the development of mathematical thinking. These findings suggest that the effectiveness of GBL may depend not only on the use of games itself but also on the types of learning-related actions and interactions that students undertake during gameplay.

Motivated by these empirical insights, the present study introduces SKUNK Probability, a structured instructional adaptation of the classic dice game SKUNK. This adaptation integrates elements of randomness, risk assessment, strategic decision-making, and reflective learning to situate probability concepts within an experiential and engaging activity. By enabling students to encounter probabilistic ideas through interactive gameplay, SKUNK Probability seeks to bridge the gap between abstract theory and intuitive understanding.

The purpose of this study is to implement SKUNK Probability as a game-based instructional activity and to examine students' engagement, perceived understanding, motivation, and perceptions of its relevance to probability learning. By situating learning in a fun, interactive, and low-cost context, this study seeks to explore how a game-based strategy such as SKUNK Probability may provide an engaging and meaningful learning experience for students learning probability.

The study was guided by the following research questions:

1. How do students rate their engagement and enjoyment after participating in the SKUNK Probability game?
2. To what extent do students perceive that the SKUNK Probability game helps them understand probability concepts?
3. To what extent do students support the use of game-based activities such as SKUNK Probability in future statistics lessons?

LITERATURE REVIEW

Game-Based Learning in Science, Technology, Engineering (STEM), and Mathematics Education

Game-Based Learning (GBL) has been widely studied as an approach to improve student engagement and learning outcomes across Science, Technology, Engineering, and Mathematics (STEM) education. Evidence from meta-analytic studies suggests that game-based approaches can support students' academic achievement when games are appropriately designed and connected to learning objectives. Wang et al. (2022) conducted a meta-analysis of 33 studies involving 3,894 students and found a significant moderate effect of digital game-based STEM education on students' learning achievement. Their analysis also showed that the effectiveness of game-based learning varied according to several factors, including the subject area, educational level, type of game, gaming platform, and duration of the intervention. Similarly, Tsai and Tsai (2020) found that game-based science learning had a medium positive effect on students' scientific knowledge compared with conventional instruction. Their findings further indicated that both learning and gaming mechanisms contributed significantly to students' scientific knowledge gains, highlighting the importance of carefully designed gaming mechanisms to address students' needs across different educational levels. Together, these meta-analyses provide evidence that game-based approaches can improve students' learning achievement.

However, they focus predominantly on digital games and science contexts, leaving space to examine simple, low-cost non-digital games such as dice-based activities for teaching probability in statistics courses.

Zooming in on mathematics education, systematic reviews indicate that games can support positive learning outcomes, while also revealing gaps relevant to the present study. Erşen and Ergül (2022) systematically reviewed 80 studies on game-based mathematics education published between 2017 and 2021. Their review found that secondary school students were the most commonly represented participants, digital computer games were the most frequently used type of game, and most studies reported positive outcomes for the use of games in mathematics education. These findings suggest that game-based approaches have considerable potential in mathematics education, while also highlighting the need for further investigation across different educational levels, mathematical content areas, and game formats. This gap provides a rationale for evaluating SKUNK, an analogue dice game designed to support the learning of probability concepts in a university classroom.

Probability Learning and Students' Difficulties

The need for alternative approaches to probability instruction is further supported by research documenting students' difficulties and misconceptions in probability. Probability is conceptually challenging because students are required not only to perform calculations but also to reason about randomness, uncertainty, sample spaces, and the likelihood of events. Andam et al. (2025), in a systematic literature review, reported that students commonly experience difficulties in learning and conceptualizing probability, with errors and misconceptions emerging as important barriers to meaningful understanding. Such difficulties are also evident in higher education. Kandeel (2019), based on the views of 24 university instructors, found that students experienced substantial difficulties in statistics and probability, particularly in topics involving permutation, combination, probability, and random variables. Similarly, Khazanov and Prado (2010) reported that misconceptions about probability were common among college students and could impede their ability to make sound judgments under uncertainty and master fundamental concepts of inferential statistics.

Taken together, these findings indicate that probability instruction should extend beyond procedural calculation and provide opportunities for students to experience uncertainty, examine outcomes, and reflect on their probabilistic reasoning. Game-based activities can provide such opportunities by embedding repeated decision-making and uncertain outcomes within an interactive learning environment.

SKUNK Probability Game and Experiential Learning

The pedagogical potential of the SKUNK game can be further explained through Kolb's Experiential Learning Theory (ELT). Kolb (1984) conceptualised learning as a cyclical process involving four interconnected modes: concrete experience, reflective observation, abstract conceptualisation, and active experimentation. Rather than treating experience itself as sufficient for learning, the model emphasises the transformation of experience through reflection and conceptualisation, followed by the application of newly developed understanding. Subsequent work has refined this perspective. Morris (2020), through a systematic review and revision of Kolb's model, highlighted the importance of active involvement, meaningful experiences, and reflection in the learning process. Similarly, Wijnen-Meijer et al. (2022) showed that connecting real experiences, reflection, theoretical understanding, and practical application can support experiential learning. Their study demonstrated how these elements can be linked through Kolb's Experiential Learning Cycle to create a more meaningful learning experience. Therefore, the SKUNK game may provide an experiential learning environment in which students learn probability concepts through active participation, reflection, and repeated application of their understanding.

Game Design Factors

Recent quantitative studies also highlight practical factors that should be considered when adapting the SKUNK game for teaching. Beyond overall learning outcomes, the effectiveness of game-based learning may depend on elements such as feedback, collaboration, interaction, and the design of the learning environment. For example, Lin and Hou (2024) found that educational board games incorporating cognitive scaffolding, immediate feedback, and collaborative interaction can enhance students' learning experiences and learning

outcomes. The role of competition also requires careful consideration, as its effects may vary across subject areas, learner characteristics, game types, and learning outcomes (Chen et al., 2020). In STEM education, a meta-analysis by Arzmann et al. (2023) reported positive effects of game-based learning on cognition, motivation, and behaviour, although the magnitude of these effects varied across student groups and educational levels. These findings inform the design of the present study, in which SKUNK gameplay is integrated with prior instruction on sample spaces (including the 36 possible outcomes when two dice are rolled), real-time recording using score sheets, and post-game activities that help students connect their gameplay experiences with probability concepts.

Research Gap and Rationale for the Present Study

The literature demonstrates that game-based approaches can enhance learning outcomes and student engagement, though much of the existing evidence comes from primary and secondary education, with relatively few studies in higher education or in the domain of probability. Students also continue to have difficulties in understanding concepts such as randomness, independence, and representativeness. This highlights the need for teaching approaches that actively involve students and help them address these misunderstandings. Experiential Learning Theory provides a useful framework for such an approach, as games such as SKUNK can help students connect actual game experiences with reflection and understanding of probability concepts. In addition, previous meta-analytic studies suggest that guidance, feedback, and structured discussions after gameplay are important for improving learning. Guided by these insights, the present study examines SKUNK as a low-cost, non-digital game-based learning activity for supporting students' engagement and perceived learning of probability concepts in higher education.

THEORETICAL AND CONCEPTUAL FRAMEWORK

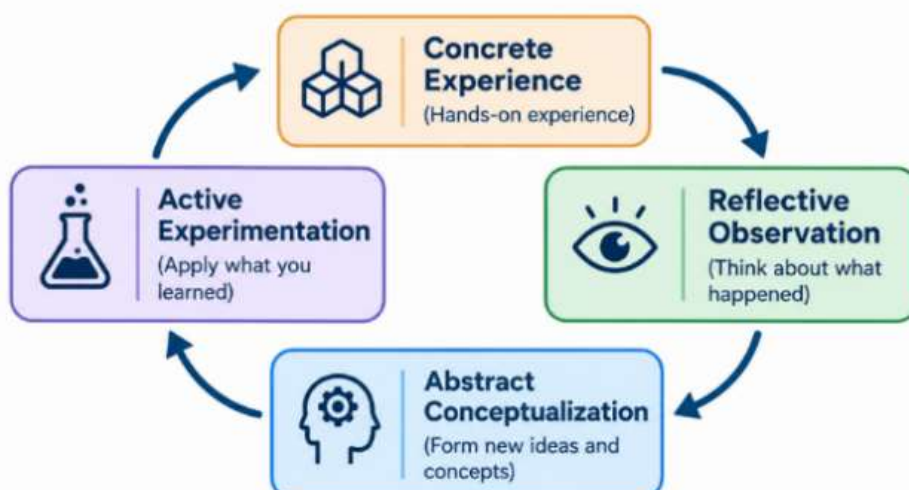
The conceptual framework guiding this study is grounded in two key pedagogical perspectives, namely Experiential Learning Theory (ELT) and Constructivist Learning Theory. Both theories emphasise the active role of learners in constructing knowledge through meaningful experiences. In the context of GBL with SKUNK Probability, these theories highlight the importance of hands-on activities, reflection, and interaction in helping students develop their understanding of probability concepts through gameplay.

Experiential Learning Theory (Kolb's ELT)

Kolb's ELT provides the primary theoretical lens for the present study. The theory conceptualises learning as a cyclical process involving four interconnected stages: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation (Kolb, 1984), as illustrated in Figure 1.

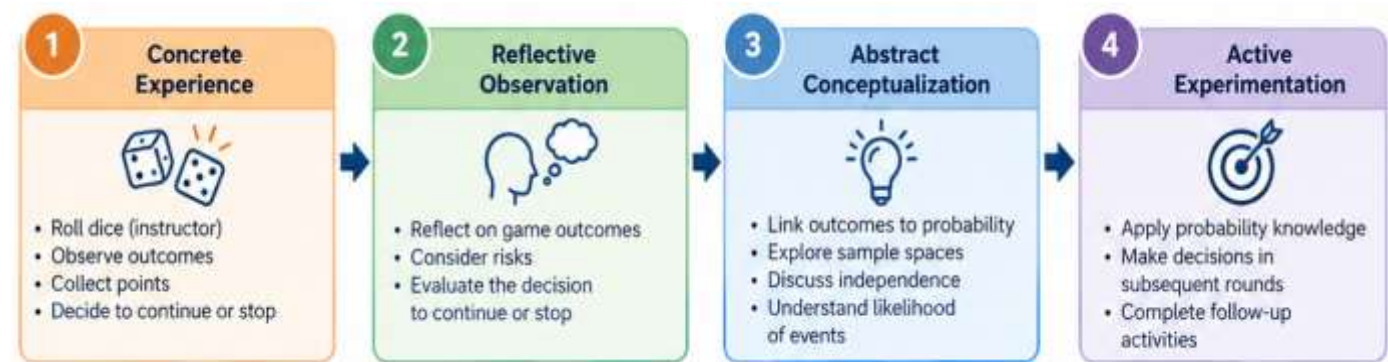
Figure 1. Kolb's Experiential Learning Cycle

Note: Figure adapted by the authors from Kolb (1984)



Although Kolb's ELT was originally introduced in 1984, subsequent research has continued to examine, refine, and apply the experiential learning cycle across different educational contexts (Morris, 2020; Wijnen-Meijer et al., 2022). Morris (2020), for example, critically reviewed and proposed a revision of Kolb's experiential learning model, while Wijnen-Meijer et al. (2022) demonstrated the practical implementation of the four-stage cycle in medical education. These studies support the continued relevance of experiential learning as a framework for designing learning activities that connect experience, reflection, conceptual understanding, and application.

Figure 2. Application of Kolb's Experiential Learning Cycle Through the SKUNK Probability Game



In the present study, the four stages of Kolb's experiential learning cycle are incorporated into the SKUNK Probability activity, as illustrated in Figure 2. The game provides students with a direct experience of random events and uncertainty through dice rolls and score accumulation. This experience forms the **Concrete Experience** stage, where students observe outcomes, collect points, and make decisions about whether to continue playing or stop. **Reflective Observation** occurs when students consider the outcomes of their decisions and reflect on the risks associated with continuing or stopping. The experience is then connected to **Abstract Conceptualization**, where the instructor relates the observed game outcomes to probability concepts such as sample spaces, independence, and the likelihood of events. Finally, **Active Experimentation** occurs when students use their understanding of probability to make decisions in subsequent rounds and complete related probability activities. Through this process, SKUNK provides a structured context in which students can experience, reflect, conceptualize, and apply probability concepts.

Constructivist Learning Theory

Constructivism emphasises that learners actively construct knowledge and meaning through their experiences and interactions with the learning environment (Bada & Olusegun, 2015). This perspective supports student-centred learning, in which teachers facilitate learning by guiding students to engage with and make sense of their experiences rather than simply transmitting information (Bada & Olusegun, 2015). Constructivist learning environments therefore encourage active participation, engagement, and interaction, enabling learners to connect new experiences with existing knowledge and develop meaningful understanding (Zajda, 2021; Triantafyllou, 2022).

In probability learning, students may rely on intuition or everyday reasoning when making judgments about uncertain events. The SKUNK game provides opportunities for students to engage with probability through repeated dice rolls, decision-making, and interaction with other players. During the game, students decide whether to continue playing and risk losing their accumulated points or stop and retain their current score. These experiences allow students to observe the consequences of chance and risk while making decisions under uncertainty. From a constructivist perspective, such active participation and interaction can provide opportunities for learners to construct and refine their understanding through meaningful experiences (Zajda, 2021). However, gameplay should be complemented by lecturer guidance to help students reflect on their experiences, articulate their reasoning, and connect their observations with formal probability concepts. In this way, SKUNK can provide a meaningful learning environment in which students actively engage with probability through experience, decision-making, interaction, and reflection.

Application in the Research Context

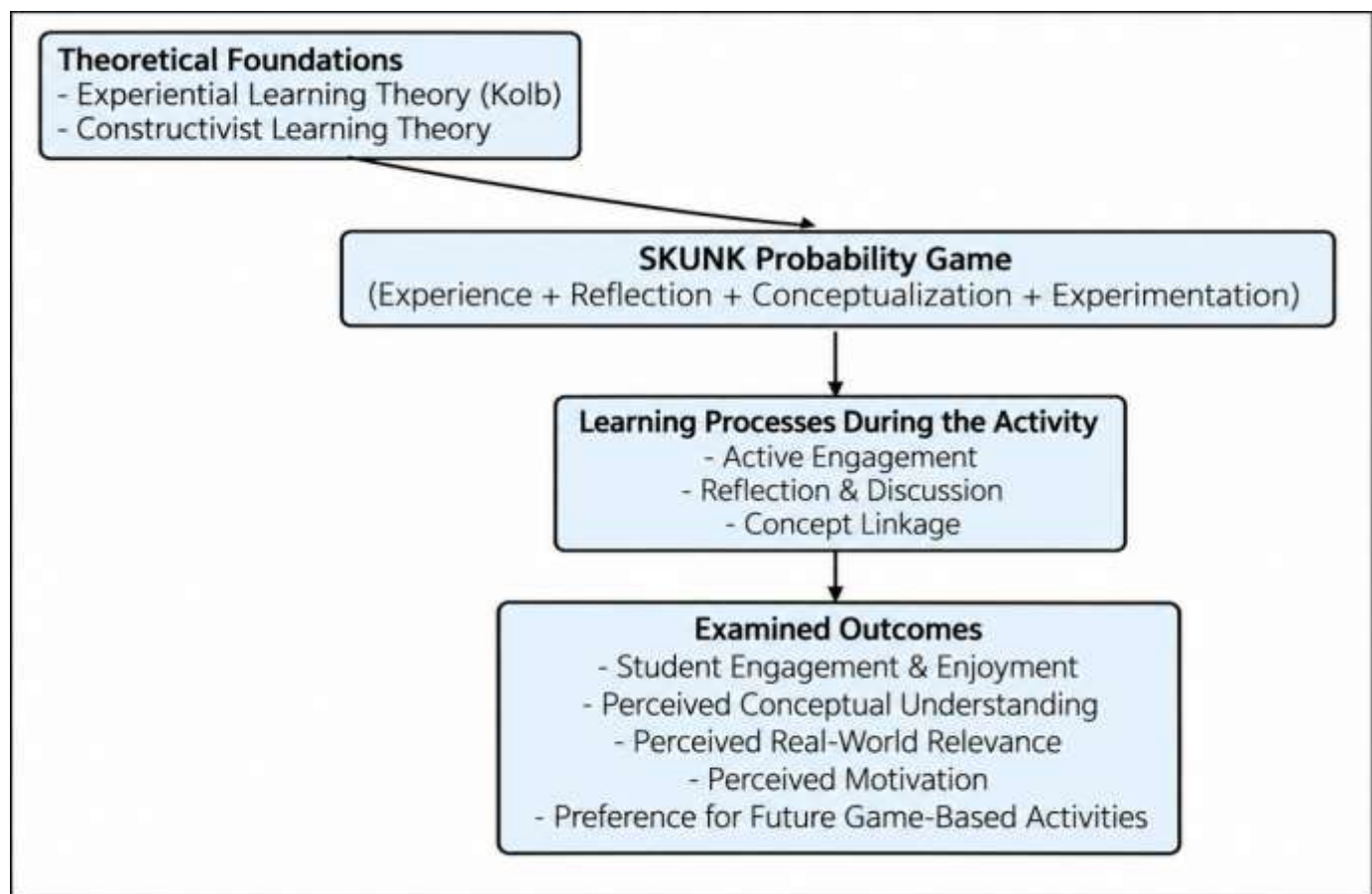
Drawing from these theories, the study operationalizes SKUNK Probability as a pedagogical learning activity and examines students' experiences and perceptions following participation in the activity. The activity was designed to provide opportunities for students to engage with probability concepts through gameplay, reflection, discussion, and reinforcement activities. The integration of gameplay, reflection, and formal exercises was designed to provide opportunities to examine:

- Students' engagement and enjoyment.
- Students' perceived understanding of probability concepts.
- Students' perceptions of the relevance of probability to real-life decision-making.
- Students' perceived motivation to learn probability.

The research investigates these outcomes through a post-activity feedback questionnaire. In doing so, the study examines students' reported experiences and perceptions following participation in a low-cost, analogue game-based learning activity.

Figure 3. Research Framework for the SKUNK Probability Game

Note: Framework developed by the authors based on Experiential Learning Theory and Constructivist Learning Theory.



METHODOLOGY

Research Design

This study employed a descriptive quantitative research design to explore students' experiences and perceptions of participating in the SKUNK Probability game. The activity was implemented in a classroom setting and structured into four sequential stages: Preparation and Instruction, Gameplay, Reinforcement Activities, and Feedback Collection, as illustrated in Figure 4.

Figure 4. Implementation Process of the SKUNK Probability Game

Note: Figure developed by the authors based on the study procedure.

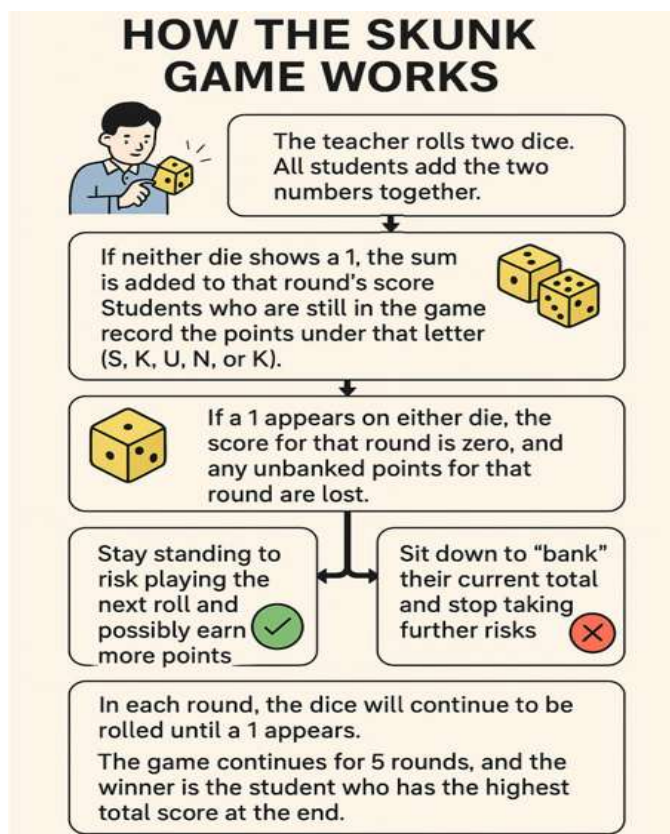


In the **Preparation and Instruction** stage, the lecturer introduced a sample space diagram illustrating the 36 possible outcomes of rolling two dice and explained the rules and procedures of the SKUNK game. This was followed by the **Gameplay** stage, in which students participated in dice rolls, S-K-U-N-K rounds, and score-related decision-making, as illustrated in Figure 5. During the **Reinforcement Activities** stage, students completed individual probability exercises and engaged in group discussions to connect their gameplay experiences with formal probability concepts, including possible outcomes and the probability of occurrence of specific events. Finally, in the Feedback Collection stage, students completed a feedback questionnaire and provided reflections on their learning experience.

The quantitative data obtained from the questionnaire were analysed using descriptive statistics to identify patterns in students' engagement, enjoyment, and perceived learning. The questionnaire was used to examine students' perceptions of the SKUNK Probability game as a learning activity rather than to measure learning gains through a pre-test and post-test design. Accordingly, the findings should be interpreted as students' reported perceptions and experiences rather than as evidence of measurable changes in probability knowledge or skills.

Figure 5. How the SKUNK Probability Game works

Note: Authors' own design, adapted from the rules of the SKUNK game.



Participants

The participants comprised Semester 2 diploma students from the Faculty of Accountancy who were enrolled in Introductory Statistics courses at Universiti Teknologi MARA (UiTM), Tapah Campus, Perak, Malaysia. These students were selected because probability is a core component of their program and is widely recognized as one of the more challenging topics in the statistics curriculum. All students in the selected classes were invited to participate in the SKUNK Probability activity, and informed consent was obtained prior to data collection. In this study, student engagement was examined descriptively through indicators of enjoyment, interest in probability, motivation, and willingness to participate in future game-based activities.

Procedure

The activity followed a structured sequence based on Kolb's experiential learning cycle:

1. **Preparation and Instruction** – The lecturer introduced the rules of SKUNK Probability and explained fundamental probability concepts using a sample space diagram illustrating the 36 possible outcomes from rolling two dice (Figure 6).

Figure 6. All possible outcomes from a single roll of two dice

Dice 2 \ Dice 1	1	2	3	4	5	6
1	(1,1)	(1,2)	(1,3)	(1,4)	(1,5)	(1,6)
2	(2,1)	(2,2)	(2,3)	(2,4)	(2,5)	(2,6)
3	(3,1)	(3,2)	(3,3)	(3,4)	(3,5)	(3,6)
4	(4,1)	(4,2)	(4,3)	(4,4)	(4,5)	(4,6)
5	(5,1)	(5,2)	(5,3)	(5,4)	(5,5)	(5,6)
6	(6,1)	(6,2)	(6,3)	(6,4)	(6,5)	(6,6)

2. **Gameplay** – The lecturer rolled two dice using the online simulator. Students calculated the sum of the dice and recorded scores on their sheets (Figure 7). After each roll, students decided whether to continue playing (risking unbanked points) or stop and keep their accumulated points. Continuing may provide an opportunity to gain more points, but it also creates the possibility of losing accumulated points when a specified outcome occurs. If a "1" appeared on either die, the round's score was zero and unbanked points were lost. The number of dice rolls within each round was not fixed and depended on the game outcomes. The student with the highest score after five rounds was declared the winner.

Figure 7. SKUNK Game Scoring Sheet

Note: Authors' own design, adapted from the SKUNK game rules.



SKUNK Scoring Sheet

Name: _____

ROUND	S	K	U	N	K
ROLL 1					
ROLL 2					
ROLL 3					
ROLL 4					
ROLL 5					
ROLL 6					
Point Earned					

3. **Reinforcement Activities** – After gameplay, students completed individual probability exercises to connect their experience with formal concepts such as sample spaces, possible outcomes, and the probability of specific events (Figure 8).
4. **Feedback Collection** – Students completed the feedback questionnaire using Google Forms, providing quantitative ratings of their learning experiences.

Figure 8. Probability Exercises Based on Rolling Two Dice in the SKUNK Game

Note: Compiled by the authors based on the probability of rolling two dice.



SKUNK MCQ Exercises

In the SKUNK game, each round involves rolling two dice.

1. How many different outcomes are possible from a single roll of two dice?

A) 6
B) 12
C) 36
D) 42

2. How many outcomes show the same number on both dice?

A) 12
B) 6
C) 18
D) 36

3. How many outcomes do not contain any '1' (i.e., the round continues, and the score is added)?

A) 36
B) 25
C) 20
D) 30

4. How many outcomes contain at least one '1', which means the score is zero?

A) 11
B) 10
C) 6
D) 25

5. How many outcomes result in both dice showing a 1 (double 1)?

A) 2
B) 12
C) 1
D) 6

6. What is the probability that no '1' appears when two dice are rolled?

A) 5/6
B) 25/36
C) 11/36
D) 1/2

7. What is the probability that at least one die shows a '1' (and the round ends with 0 points)?

A) 5/6
B) 1/3
C) 25/36
D) 11/36

Questionnaire and Data Collection

A post-activity feedback questionnaire was administered through Google Forms to obtain students' perceptions of the SKUNK Probability activity. The questionnaire covered students' engagement and enjoyment, perceived understanding of probability concepts, perceived real-life relevance, motivation, and preference for similar game-based activities. Perception items used a five-point response scale from strongly disagree to strongly agree, while enjoyment and interest items used appropriate categorical response options. The questionnaire was administered immediately after the activity.

The questionnaire was developed based on the research questions and learning objectives of the activity and was used as a descriptive feedback instrument rather than a formally validated psychometric scale. Formal validity and reliability testing were therefore not conducted. Data were analysed using descriptive statistics, specifically frequencies and percentages, and the findings were interpreted as students' reported perceptions and experiences rather than measures of learning gains.

RESULTS

The probability exercises in Figure 8 were intended for reinforcement and were not used for measurement purposes. Therefore, they were excluded from the formal data analysis. The quantitative data obtained from the feedback questionnaire were analysed using descriptive statistics to identify patterns in student engagement, enjoyment, and perceived learning.

1. Demographic Profile of Respondents

A total of 43 students responded to the feedback questionnaire. The respondents comprised Semester 2 diploma students from the Faculty of Accountancy at Universiti Teknologi MARA (UiTM), Tapah Campus, who were enrolled in an Introductory Statistics course. In terms of gender, 83.7% of the respondents were male, while 16.3% were female. The uneven gender distribution should be considered when interpreting the findings, as the results may primarily reflect the experiences and perceptions of the respondents represented in this sample.

2. Evaluation of Activity Enjoyment and Students' Interest in Probability

Students reported highly positive levels of enjoyment and interest following participation in the SKUNK Probability Game. As shown in Figure 9, 100% of the respondents rated the activity as either very enjoyable (81.4%) or enjoyable (18.6%). The absence of neutral or negative ratings indicates highly positive student perceptions of the activity. In addition, as shown in Figure 10, 65.1% of students reported a very high level of interest in probability after the activity, while 27.9% reported a high level of interest and 7.0% reported a moderate level of interest. These findings indicate that students reported high levels of interest in probability following participation in the SKUNK Probability Game.

Figure 9. Enjoyment of the SKUNK Probability Game (n = 43)

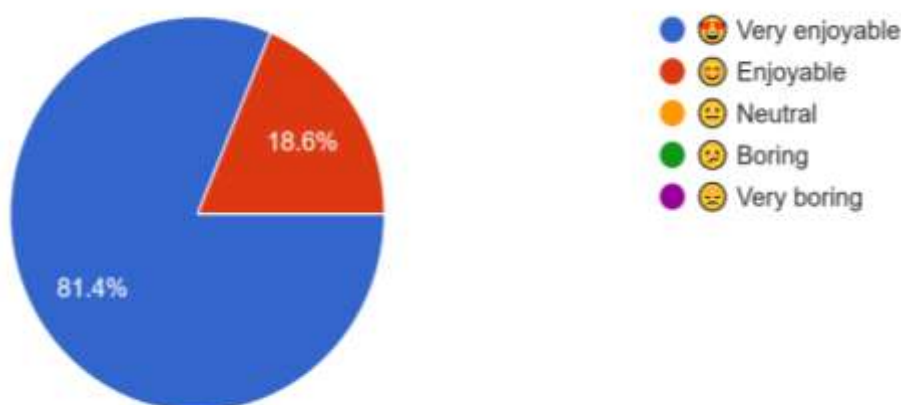
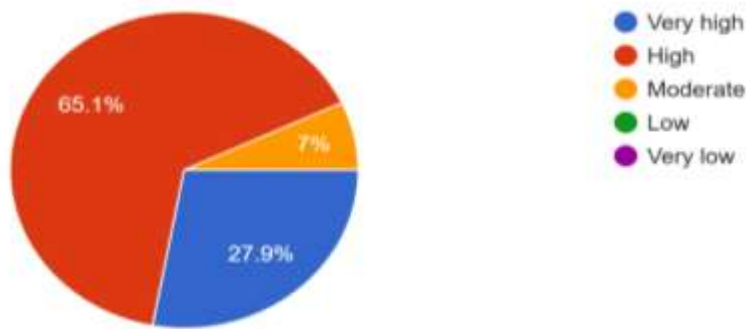


Figure 10. Students' Interest in Probability After the Activity (n = 43)



3. Students' Perceived Learning and Motivation

The findings showed highly positive student perceptions of the activity in relation to their understanding of probability concepts and motivation to learn, as shown in Table 1. A large majority of respondents (97.6%) either strongly agreed (67.4%) or agreed (30.2%) that the SKUNK game helped them understand probability concepts better. Similarly, 95.2% of respondents either strongly agreed (58.0%) or agreed (37.2%) that the activity helped them see how probability applies to real-life decision-making. From a pedagogical perspective, 95.4% of respondents indicated that the follow-up probability questions were helpful in reinforcing their understanding of the topic. Furthermore, 93.0% of respondents either strongly agreed or agreed that they felt more motivated to learn about probability following the SKUNK game.

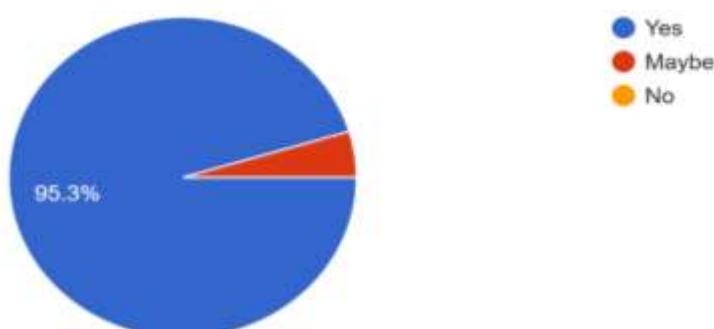
Table 1. Students' Responses Regarding Perceived Understanding and Motivation

Item	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The SKUNK game helped me understand the concept of probability better.	67.40%	30.20%	2.40%	0%	0%
The game helped me see how probability applies to real-life decision-making situations.	58.00%	37.20%	4.80%	0%	0%
After the game, the follow-up probability questions were helpful in strengthening my understanding.	44.20%	51.20%	4.60%	0%	0%
I felt more motivated to learn about probability following the SKUNK game.	53.50%	39.50%	7.00%	0%	0%

4. Future Implementation Preference

A large majority of respondents supported the inclusion of similar game-based activities in future lessons. A total of 95.3% of respondents answered "Yes" when asked if they would like to have more game-based activities like SKUNK in future lessons (see Figure 11). This finding suggests a strong student preference for pedagogical approaches that incorporate active, game-based elements.

Figure 11. Students' Preference for More Game-Based Activities (n = 43)



FUTURE WORK

Although this study highlights positive student perceptions of SKUNK Probability in relation to engagement and conceptual understanding of probability, several limitations provide directions for future research. First, the implementation was limited to a single institution and a relatively small cohort of diploma students. This narrows the scope of generalizability, as different educational contexts, class sizes, and disciplines may yield varying outcomes. Expanding the study to include multiple institutions, secondary schools, or international samples would strengthen the external validity of the findings.

Second, the study relied primarily on student feedback and descriptive analysis. While valuable, these measures do not provide robust evidence of learning gains over time. Future studies should employ experimental or quasi-experimental designs, incorporating pre- and post-tests, control groups, and longitudinal follow-ups to evaluate both short-term and long-term impacts of the intervention.

Finally, future research could explore digital enhancements of SKUNK Probability, such as a web-based version with virtual dice, automated score recording, and real-time displays of game outcomes. Such digital features could facilitate data collection and provide students with immediate feedback on their decisions and probability outcomes. Comparing the traditional and digitally enhanced versions could further examine whether digital features are associated with differences in students' engagement and learning experiences in probability.

DISCUSSION

The findings of this study indicate that the SKUNK Probability game was well received by students, with respondents reporting positive levels of engagement, motivation, and perceived understanding of probability concepts. All respondents described the activity as enjoyable, while most students reported high levels of interest and indicated that they felt more motivated to learn probability following the activity. These findings are consistent with previous studies suggesting that game-based learning can increase student participation and create a more interactive learning environment than traditional lecture-based approaches (Wang et al., 2022; Tsai & Tsai, 2020).

Students also reported positive perceptions regarding their understanding of probability-related ideas, including randomness, risk, and decision-making. Such experiences may help make abstract probability concepts more meaningful and easier to relate to real-life contexts following the activity. Through repeated gameplay, students were provided with opportunities to experience probability concepts directly rather than relying solely on formulas and theoretical explanations. This is consistent with Prince (2004), who highlighted the benefits of active learning in promoting student engagement and learning. The learning process reflected in the activity can also be understood through Kolb's Experiential Learning Theory. During the game, students were provided with opportunities to gain concrete experience, reflect on their outcomes, connect these experiences to probability concepts, and apply these ideas in follow-up exercises. The activity also reflected constructivist learning principles by allowing students to actively construct knowledge through interaction, discussion, and reflection.

Another important finding was that students reported that the activity helped them relate probability concepts to real-life decision-making. The game required students to balance risk and reward when deciding whether to continue or stop during each round. This provided students with an opportunity to consider how probability may relate to decision-making in everyday situations. Such experiences may help make abstract probability concepts more meaningful and relevant to real-life contexts.

However, an important limitation of this study is its reliance on self-report data. Students' perceptions of their understanding, as measured by the feedback questionnaire, may not reflect their actual gains in probability knowledge and skills. Previous research has shown that self-reported learning may not always accurately reflect actual learning outcomes (Porter et al., 2011). Sitzmann et al. (2010) also found that students' self-assessments were more closely related to motivation and satisfaction than to actual cognitive learning. Therefore, the positive responses in this study should be interpreted as evidence of students' perceived learning and engagement rather than as direct evidence of improved probability knowledge and skills.

Future research should complement self-report measures with objective assessments, such as pre- and post-tests of probability knowledge, and preferably include a control or comparison group. Such research would help determine whether the positive perceptions observed in this study translate into measurable improvements in students' probabilistic reasoning and problem-solving abilities.

The strong support for more game-based activities in future lessons suggests that students value interactive and student-centred learning approaches. Although this study was conducted at a single institution and relied mainly on descriptive analysis, the findings suggest that SKUNK Probability may provide a practical and low-cost teaching activity that offers students an engaging, meaningful, and accessible learning experience in probability.

CONCLUSION

This study examined the use of SKUNK Probability as a game-based learning activity for teaching probability concepts among diploma students. The findings indicate that students responded positively to the activity, particularly in terms of enjoyment, interest, motivation, and perceived understanding of probability. Most respondents also perceived that the game helped them connect probability concepts with real-life decision-making and expressed support for incorporating similar game-based activities into future statistics lessons. These findings suggest that SKUNK Probability may provide a practical and low-cost approach for creating an engaging learning environment in probability education.

The integration of gameplay, reflection, and reinforcement activities was consistent with the principles of Experiential Learning Theory and Constructivist Learning Theory, providing students with opportunities to experience uncertainty, make decisions, reflect on outcomes, and connect their experiences with formal probability concepts. However, the findings should be interpreted as evidence of students' perceived learning and engagement rather than direct evidence of improvements in probability knowledge or skills, as the study relied on self-reported data and descriptive analysis without pre- and post-assessment. Nevertheless, the positive responses suggest the potential of SKUNK Probability as an accessible pedagogical activity for supporting probability instruction in higher education. Future research should employ objective learning assessments, larger and more diverse samples, and experimental or quasi-experimental designs to further examine whether the activity is associated with measurable changes in students' actual probability learning and reasoning.

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