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Research Article

Thematic Analysis of Students' Reflections on ProNaja X2 – Board Game in Learning Basic Programming

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Abstract

ProNaja X2 is an innovation of the classic snake-ladder board game designed specifically as a tool for learning basic programming concepts. In this study, we examined the potential of the ProNaja X2 learning tool as a motivation and engagement changer of participants towards a game-based learning approach (GBL). Qualitative research was conducted on nine participants from undergraduate education students majoring in Information Technology from three different series of admission sessions at Universiti Pendidikan Sultan Idris (UPSI). Participants followed ProNaja X2 intervention sessions periodically for seven weeks starting from the seventh week of the study. Thematic analysis based on participant interview transcriptions and intervention session observation reports revealed themes centred on the dimensions of the learning domain, namely cognitive, affective and psychomotor. In the cognitive dimension, the ProNaja X2 game has the power to be a stimulating factor in the information processing cycle as well as help the construction process of new knowledge. In the affective dimension, the ProNaja X2 game has the power to change the student's level of excitement in a more positive direction towards learning basic programming. In the psychomotor dimension, the challenges in ProNaja X2 have the potential to be a driving factor for student involvement in being active in socialising and interacting in order to achieve meaningful learning goals.

Keywords: Game-based Learning (GBL), qualitative thematic analysis, programming, motivation, engagement.

INTRODUCTION

A computer, an electronic device that receives, processes and generates input, is at the forefront of relentless development, driving rapid evolution in its field. This evolution extends to Malaysia, which is grappling with the repercussions of this rapid change. The country is facing a pressing challenge: a scarcity of highly skilled workers to cater to the demands of various industries, particularly those centred around emerging technologies (Mohamad, 2021; Mohamad, 2022). Malaysia requires a consistent influx of talent in various fields, such as robotics, Artificial Intelligence (AI), science, nanotechnology and genetic engineering, to adapt to the changes in technology (Abdullah, 2022; Hasbullah et al., 2022). The technologies listed would not exist without the foundation of computer

science, particularly in the knowledge of writing algorithms as well as low-level and high-level instructions – the science of programming, to be fed into electronic devices equipped with main processing chips. One of the main reasons why programming knowledge is crucial today is the need for automation and control systems that foster human-machine interaction (Sudin et al., 2022). However, according to Ahmad and Ghazali (2020), many students nowadays have a negative perception of this discipline – they claim that the subject is difficult and a killer subject at the higher education level. This perception is passed down from generations that have already learned programming to the beginner generations.

The Ministry of Education Malaysia and higher learning institutions in Malaysia, through their teachers, lecturers and educators in related fields, must shoulder a significant responsibility in eradicating these negative perceptions and focus their efforts on producing a generation that is skilled, knowledgeable, intelligent and constantly aware of changes in both analogue and digital data environments (Hasan et al., 2014). They should also strive to cultivate critical and creative thinking, applying computational thinking in writing program codes with the assistance of intelligent machines.
ProNaja X2 – a classic snake and ladder board game specifically designed to address the aforementioned issues. This research paper reports on students' reflections on the use of ProNaja X2 in the context of GBL learning in basic programming. The analysis of this research focuses on two research questions: (1) Does ProNaja X2 have the potential to act as a catalyst for changing students' motivation in basic programming courses? and (2) Does ProNaja X2 have the potential to act as a catalyst for students' engagement in basic programming courses?

LITERATURE REVIEW

There is a range of issues concerning the students' proficiency in grasping programming concepts (Rosman & Hamid, 2020). Learning programming for students at the beginner or novice level is challenging and demands that they engage in active activities that utilise problem-solving skills. Students need to know the syntax of computer languages before they can come up with a program. Students are also found to lack interest in theoretical learning, resulting in difficulties in producing program code to solve simple programming problems (Quah et al., 2023). The approach employed by instructors in handling programming classes is also a contributing factor to students' lack of interest in the course (Rahmat et al., 2012). Curriculum developers and instructors need to recognise the importance of students' attitudes towards programming, strive to provide quality materials, and be prepared to improve learning strategies to cultivate positive changes in the field of programming (Omar et al., 2022).

To overcome these persistent issues, a comprehensive reform in teaching strategies is necessary. Educators must shift towards student-centric methods that emphasise interactivity and creativity. This includes integrating visual-based and game-based learning elements, reducing abstract theoretical delivery, and supporting collaborative peer-to-peer activities. Teachers should also introduce real-world mini projects that involve coding challenges and scaffold according to difficulty levels (Azman et al., 2024; Zamzuri et al., 2024). Additionally, frequent formative feedback and personalized learning paths can help reduce students' anxiety and sustain engagement. These changes will encourage cognitive development while cultivating a more positive emotional association with learning programming.

Learning activities involving games can attract students' interest, particularly in programming courses (Wong et al., 2018). The use of games as a teaching tool in programming courses is likely to improve performance and motivate students to learn (Priyaadharshini et al., 2020). Integrating game elements into programming courses may lead to positive motivational impacts (Pilkington, 2018). Additionally,

Mohamad (2020) recommends researching the GBL approach to assess the usefulness of games in influencing student learning motivation. Besides, knowledge of GBL and its impact on student motivation and engagement will create new dimensions for the planning of meaningful learning processes (Omar, 2023; Zolkipli et al., 2023). These assertions are echoed by scholars such as Barab and Dede (2007), who advocate for immersive and meaningful learning through designed environments. Their perspectives reinforce the notion that GBL provides a pedagogical bridge between motivation and measurable learning outcomes.

Playing board games outside of class can be a highly effective method for students to learn. Suitable board games can serve as a support system for student success. Furthermore, playing board games outside of class can enhance communication skills, problem-solving and critical thinking (Barrett, 2023). Board games can provide students with opportunities to apply learned concepts while encouraging cooperation, inquiry and critical thinking. By using curriculum-aligned board games, students can enjoy learning through play and, at the same time, boost their achievement.

Learning Theory, Motivation and Engagement in Game-Based Learning

The GBL approach incorporates three interrelated learning theories, namely behaviorism, cognitivism and constructivism. The behaviourist learning theory posits that learning takes place when there is a change in an individual's behaviour in response to stimuli in the environment. Any individual who does not respond to environmental stimuli is considered a passive learner. These passive learners depend entirely on the external environment and other individuals to initiate changes in their behaviour. This theory was pioneered by thinkers such as John Watson and further developed by Edward Thorndike, Ivan Pavlov, and B.F. Skinner (Ang & Lim, 2019).

The cognitivist learning theory is based on the human brain's ability to think and remember experiences and behaviours. The thinking and remembering processes occur within the individual. Inferences about internal events like thinking and remembering can be made as long as they are paired with careful observation of behaviour. The cognitive theory emphasises an organism as an active information processor that adapts to new experiences, links them to previous ones, and organises this information for storage and retrieval. Cognitive psychologists also acknowledge that learning can occur without clear behavioural changes.

The constructivist learning theory is rooted in the concept of construct, which means "to build". According to this theory, learning occurs when new cognitive schemes are constructed or restructured through an individual's reflection on their experiences in the environment. The constructivist perspective involves two main principles: (1) knowledge is actively constructed by the learner rather than passively received from the environment. (2) knowing – based on the process of adapting to experiences in the environment. This learning concept demonstrates the active involvement of the learner during the learning process, where the learner actively reconstructs understanding and expands knowledge as a result of various activities experienced through interaction with the environment. This theory was initiated by thinkers like John Dewey and further developed by Marie Montessori, Davis Kolb, Lev Vygotsky and Reuven Feuerstein (Ang & Lim, 2019).

Motivation is pivotal in capturing students' interest and is a vital "ingredient" in fostering learning effectiveness. Understanding these motivational theories helps researchers identify the types and dimensions of motivation and their relationship with the learning theory in GBL. There are three motivational theories based on the findings of several psychologists, such as (1) Malone and Lepper (Intrinsic Motivation), (2) Deci and Ryan - *Self Determination Theory* (SDT) and John Keller (ARCS

Motivation Model).

Engagement is a crucial element in the design of effective teaching and learning practices. Engagement refers to a sense of purpose, ownership and commitment to a subject or task. The Engagement Theory serves as a framework for technology-based teaching and learning (Kearsley & Schneiderman, 1999). At its core, this theory is driven by the idea of meaningful student involvement in every learning activity through social interactions to perform beneficial tasks. The fundamental principle of student engagement is that students collaborate in activities that involve active cognitive processes like creating, problem-solving, predicting, decision-making and evaluating. The three main components of the theory are (1) connect, (2) create, and (3) contribute.

Based on the literature review, we can conclude that the introduction of the GBL approach to basic programming courses is not something new. This research paper is part of our (researchers' and lecturers') initiative to change the negative perception of the programming discipline to a more positive one. Most of the past studies reviewed were empirical, presenting numerical results focusing on students' academic achievement when a specific treatment was applied. Hence, our research paper is unique in its qualitative research approach with thematic analysis, focusing on observing the phenomenon of students' learning experience exploration.

RESEARCH METHODOLOGY

This qualitative research utilised a purposive sampling technique, and the research process was carried out through the voluntary participation of nine participants among students of the Bachelor of Education in Information Technology from three different intake series at Universiti Pendidikan Sultan Idris (UPSI). Each participant diligently attended the ProNaja X2 intervention sessions regularly for seven weeks, beginning from the seventh week of lecture. Table 1 shows details of the research participants.

Table 1: ProNaja X2 participant information

Participant Group Code	Intake Session	Number
K1	A211 2021/22	3
K2	A212 2021/22	3
K3	A221 2022/23	3

K1, K2 and *K3,* respectively, represent the first, second and third groups of research participants. The participants were students from the A211 2021/22, A212 2021/22 and A221 2022/23 intake sessions who enrolled in the Basic Programming Principles course. The duration of the research spanned three semesters. Interaction with each research participant commenced with *K1* and ended with *K3.* Intervention sessions for each group were conducted from the seventh week of learning to the 14th week of learning. Each intervention session lasted only one hour.

This research reports on students' reflections on the use and intervention of the ProNaja X2 gaming tool in the Basic Programming Principles course. The analysis of the research findings focuses on the previously stated research questions. The research data is obtained in the form of video recordings through (1) observational video recordings and (2) video recordings of interviews with research participants. With camera facilities readily available in mobile devices like smartphones, researchers opted to obtain data through video recordings. Researchers are able to replay, slow down, zoom in or

edit video clips as needed by the research.

Table 2 illustrates the constructs of the research instrument used in this research. The data collection process was conducted sequentially for each group of participants involved. Observation, labelled as *P,* refers to the researcher's visual observation of the participant's reaction, body language and response during the ProNaja X2 intervention gaming session. The researcher was present at the research site along with the participants to observe their interactions with the gaming product. This form of observation is known as participatory observation, where the researcher also acts as a facilitator in the intervention session.

Table 2: Relationship between participants and research instrument

Research Instrument	**Code**	**Description**	**Participant Group Code**	**Number of Participants**	**Data Type**
Observation week $n \leq 7$	*P*	5 sessions– *K1*	***K1***		
		6 sessions– *K2*	***K2***		Video
		7 sessions – *K3*	***K3***	**9 (***3 from each group)*	
Focused Interview *TBF question set*	*TBF*	Researcher-student focused interview, 1 session/group (question set C and D)			Video, WhatsApp text messages

The choice of qualitative research with thematic analysis was made based on a small sample selection. This research did not study the impact of GBL on students' academic achievement. Instead, it focused on cultivating interest and stimulating student engagement by offering learning opportunities through playing ProNaja X2.

FINDINGS

The thematic analysis method was used to gather information on student reflections on ProNaja X2 through 18 observational datasets (*od)*, and nine conversation transcripts (*ct)* with the students. The analysis data for *od* and *ct* were carried out consecutively, beginning with *od* and followed by *ct.*

The *od* observation log was read a few times, and key segments that helped achieve the objectives and research issues were identified. These marked segments represent words that describe the observed student's state, recorded during the intervention session. These successfully recorded student states – like facial expressions, body language, eye movements, and natural actions- are spontaneous sentiments that facilitate the acquisition of research findings. The conversation transcript was read multiple times, and important segments of the conversation were identified and reviewed. These identified segments include words and statements representing the students' responses, which were obtained from video recordings and text messaging in the WhatsApp application. The marked data from the *od* and *ct* processes is transferred to spreadsheet software for coding, which generates initial themes and defines the themes. The themes were studied, and each was matched with a relevant research question -elements that relate directly or abstractly to motivation and engagement. To assist in the matching process, we used the core learning domains, namely psychomotor, affective and cognitive dimensions. Table 3 illustrates the final thematic analysis hierarchy for *od* and *ct.*

Affective Dimension

The theme in the affective dimension involves feelings or emotions, which were highlighted through observations like "excitement", "smile-laughter", "curiosity", and "happiness". The affective dimension is also obtained through excerpts of research participants' transcripts, as shown below;

"Yes, sir, I have improved my understanding and learning related to this program. I told my friends, I participated in this activity, learning C++ through games is fantastic, there's no stress or headaches, especially since I'm less focused in class, this activity has been really helpful, seriously.." ***K2 male student.***

Table 3: Thematic analysis hierarchy for *od* and *ct*

Observational data (od)	**Code**	**Theme**	**Dimension**	**Dimension**	**Theme**	**Code**	Conversation transcripts (*ct*)
	O1	excitement	affective	affective	motivation	*T2*	
	O3	smile-laughter			communication	*T5*	
	O7	curiosity			relationship	*T6*	
	O8	happiness			confidence	*T7*	
	O2	focus	cognitive				
	O5	hardworking					
	O6	interaction	psychomotor	psychomotor	behaviour	*T1*	
					colloborative	*T3*	
	O4	active	cognitive psychomotor				
	O9	competitive	affective, cognitive, psychomotor	affective, cognitive, psychomotor	dominant learning domain	*T10*	
				self-management, management	time	*T4*	
					work rate	*T8*	
					external support	*T9*	

Psychomotor Dimension

The theme in the psychomotor dimension involves students' body language – this is observed through the student's body coordination during ProNaja X2 game intervention, dice throwing, moving game pieces, selecting question cards, reaching and arranging programming blocks and attempting to solve questions on the panel provided. This dimension is observed through "interaction", students being "active" and "competitive". The dimension is also obtained through excerpts of research participants' transcripts, as shown below;

"Every week, I feel so excited just to attend ProNaja. Hehe. So eager to answer questions. Even if I win but don't get the questions, I feel a bit dissatisfied." – ***K3 female participant.***

"…I'm thrilled and eager. At the start, I felt like I didn't care about getting a question; I just wanted to win. But later, if I didn't get a question, I got frustrated. It is more fun to get a question than to rush to the finishing line." ***K3 female participant.***

Cognitive Dimension

The theme in the cognitive dimension involves the information-processing cycle that serves as the foundation for individuals to make decisions in problem-solving. This dimension can be classified as an intellectual trait. It is observed through "focus", "diligence", "active", and "competitiveness". The dimension is also obtained through excerpts of research participants' transcripts, as shown below;

"I strongly believe that everything depends on one's willingness to learn, as well as the method and approach. If one truly takes advantage of ProNaja, especially by participating in it each week, it can greatly help in learning programming because the focus of ProNaja is higher compared to classes with lecturers. So, that's all that I can say, active involvement truly helps in attaining skills and knowledge in programming" – ***K2 male participant.***

DISCUSSION

Mapping Learning Domains to Outcomes

The construct that maps the dimensions of the learning domain to the intended research outcomes begins with the development of deep, intrinsic interest, representing the affective domain. This foundational interest, consistent with Malone and Lepper's (1987) theory of intrinsic motivation, was effectively stimulated through the game-based structure of ProNaja X2. The design features of the game—such as challenge-based progression, peer interaction, and real-time feedback—fostered voluntary engagement, which gradually transformed into sustained internal drive among participants. As the game sessions progressed, this affective stimulation transitioned into observable behavioural changes, particularly in the form of psychomotor responses. These included heightened body movement, task-oriented actions, and focused interaction with game elements and peers. These behaviours reflect the learners' readiness and confidence to respond to programming challenges in an active manner. Subsequently, as students developed familiarity with coding tasks embedded within the game, there was clear evidence of growth in the cognitive dimension, especially in terms of decision-making, logical structuring of code, and articulation of programming concepts. Thus, the GBL approach employed in ProNaja X2 has successfully activated the three domains of learning—affective, psychomotor, and cognitive—in a progressive, integrated manner.

Holistic Impact on Student Behaviour

Throughout their involvement in the ProNaja X2 sessions, participants consistently demonstrated a holistic development across all learning dimensions. Their reflections, analysed thematically, revealed how initial curiosity and emotional engagement (affective) evolved into strategic participation and collaboration (psychomotor), which in turn enhanced conceptual understanding and coding fluency (cognitive). Notably, student comments suggested that motivation was not static, but increased with each successful round of gameplay, especially when collaborative achievements were recognised and rewarded. The integration of game mechanics such as challenges, scoreboards, and surprise elements triggered emotional and cognitive investment, while the physical interaction with the board, cards, and programming blocks reinforced psychomotor learning. This cyclical reinforcement—starting from

intrinsic interest, progressing through behaviour, and culminating in intellectual mastery—positions ProNaja X2 as a powerful pedagogical tool. In essence, the game encouraged students to stay competitively engaged while also deepening their understanding of programming principles in a low-pressure, enjoyable setting. These reflections provide compelling support for the integration of GBL as a transformative model in beginner-level programming education.

Emergent Findings Through Observational Insights

Beyond the primary findings, the study also uncovered several emergent implications that were not anticipated in the original research design. One notable discovery was the development of rapport between facilitators and students. For each group (*K1*, *K2*, and *K3*), at least one student continued seeking academic support beyond the formal ProNaja X2 sessions. This extended interaction suggests that game-based interventions may also foster stronger mentoring relationships, which can further enhance student learning outside structured environments. Another emergent pattern was the deep psychological bonding of students with the game's challenges. Many participants reported strong emotional reactions to the game outcomes, including excitement, frustration, and determination—all of which indicate the formation of intrinsic goals related to gameplay. These emotional markers were consistently observed by the researcher through participatory observation techniques, which focused on students' non-verbal cues such as facial expressions, reaction timing, posture shifts, and peer interactions. The qualitative richness derived from these observations highlighted gradual behavioural shifts, particularly among quieter students who began taking initiative during gameplay. Such developments underscore the value of integrating naturalistic observation methods into GBL research to uncover subtle learning dynamics not always apparent in self-reports or quantitative metrics.

Reflection on Methodological Limitations and Opportunities

While this study has successfully illuminated several positive outcomes arising from the use of ProNaja X2, it is also important to acknowledge the inherent limitations of qualitative research. Game-based learning often evokes enjoyment and enthusiasm, but such outcomes, when derived through narrative and thematic approaches, are susceptible to subjective interpretation. The absence of numerical validation through controlled experimental designs may limit the generalisability of findings across larger populations. Nonetheless, these limitations also present opportunities. The complexity of learning, especially when intertwined with emotion and social interaction, cannot always be distilled through metrics alone. Hence, this research contributes by offering in-depth, context-rich insight into how GBL influences motivation and engagement. It also invites further exploration of how qualitative and quantitative methods can be combined—perhaps through mixed-methods studies—to deepen the understanding of pedagogical impact. Despite its scope being minimal at this stage, the findings from ProNaja X2 provide a strong foundation for expanded implementation and evaluation across multiple cohorts or institutions.

CONCLUSION

The promising results of this study prompt researchers to consider a broader, more scalable implementation of the GBL approach at both higher education and school levels. It is recommended that future studies adopt Computer-Assisted Qualitative Data Analysis Software (CAQDAS) tools to enhance data organisation, transparency, and academic rigour. In this research, the Delve web-based platform was utilised to systematically code and thematise observation notes and interview transcripts. The use of such tools enables the generation of visualizations—such as code networks and theme hierarchies—which can offer deeper insight into student patterns and improve the clarity of reporting.

Incorporating graphical outputs from Delve or similar platforms into future papers will elevate their scientific value and appeal. Furthermore, researchers may consider extending this manuscript to a 12-page version (excluding references) to allow a comprehensive discussion of the analytical process, tool usage, and emerging pedagogical implications. This progression will help establish GBL interventions like ProNaja X2 not just as engaging activities, but as methodologically sound contributions to the field of programming education research.

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CONFLICTS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

AUTHOR CONTRIBUTIONS

Fizaril Amzari Omar: Data curation, Investigation and Writing. **Maizatul Hayati Mohamad Yatim**: Supervision and Reviewing, **Erni Marlina Saari**: Supervision and Reviewing. **Sulaiman Anter**: Reviewing and Editing. **Badelbaeva Yulduz Orifjonovna**: Reviewing and Editing

DECLARATION OF GENERATIVE AI

The authors declare that no generative AI was used in the writing of the manuscript.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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