The effect of worked examples in fostering creative thinking within game-based learning environments

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Abstract

The current study investigated the impact of worked examples on creative thinking within the game-based learning (GBL) environment. Research has found the growing importance of creative thinking in dealing with complex problems and the potential benefits of GBL in fostering creative thinking skills. However, the effects of GBL vary and sometimes GBL alone does not necessarily lead to positive learning outcomes, and therefore instructional supports is thus needed to optimize learning outcomes. Worked examples have been identified as a promising instructional support for promoting cognitive processes and problem-solving skills such as creative thinking. The study aimed to explore whether worked examples in GBL significantly promotes creative thinking outcomes which were operationalized as fluency, flexibility, and originality. The research design involved a quantitative experimental approach where participants engaged in a game-based learning activity using Minecraft, with the experimental group having access to the worked example that shows a potential thinking process of constructing a house in forms of pictures and text. The creative thinking level was measured using an existing instrument of Alternative Uses Task (AUT). The findings of the study suggested that the worked example in the current study had a significantly negative effect in fluency and flexibility, and no significant effect on originality was found. Potential causes such as fixation effect and near or far analogy were discussed subsequently.

Key words: Game-based learning, creative thinking, Minecraft, worked example

1. Introduction

1.1. Problem Statement

In recent years, game-based learning (GBL) environments have gained significant attention as effective tools for fostering learning experiences across various educational domains to develop twenty-first century skills, such as learning and innovation skills (Qian & Clark, 2016), and information, media and technology skills (Binkley et al., 2012). One of the skills is creative thinking, which has increasingly become an essential skill for planners (Mumford et al., 2017), business organizations (Im et al., 2015), and educational designers (Yang et al., 2022) to deal positively with rapid changing and complex problems. Creative thinking skill is also regarded as a crucial skill to be utilized by individuals, teams, and organizations across various settings involving both children (Khoiriyah & Husamah, 2018) and adults (Hoffmann et al., 2020) to solve problems. Besides, it has been demonstrated as significant in education, ranging from primary grade classrooms (Somwaeng, 2021) to high educations (Burnett & Keller-Mathers, 2017). Researchers have investigated the effect of GBL environments on creative thinking development and found them promising (Behnamnia et al., 2020; Gonzalo-Iglesia et al., 2018; Chen, 2023). For example, Gonzalo-Iglesia et al (2018) conducted an experimental study to examine the effectiveness of GBL in fostering creative thinking using commercial board games in higher education. Through experimental interventions across various bachelor degree courses, the study found that GBL sessions significantly boosted student motivation, and enhanced creative thinking.

However, while the potential benefits of GBL have been widely acknowledged, the effects of the learning outcome vary within a wide range and sometimes far from the expected results (ter Vrugte & de Jong, 2016). In a study conducted by Duncan (2020) that compared the effectiveness of immersive GBL activities with traditional small-group learning methods, the result indicated that the GBL activity did not yield additional benefits in fostering student creative thinking skills. This might be because the knowledge gained in GBL environment is at the risk of being implicit and tacit (Vrugte & Jong, 2016). To address this issue, instructional support, which is widely utilized to assist GBL, is necessary to facilitate engagement with cognitive processes, helping players to identify, select, and organize new information (Wouters & Van Oostendorp, 2013). Worked examples, as one such form of support, have shown promise in enhancing diverse learning outcomes such as cognitive processing (Wouters, 2017), problem-solving skills (Shen & O'Neil, 2006), and learning motivations (Oehme, 2019) within GBL environments . However, their effectiveness in specifically improving creative thinking skills within these environments remains underexplored.

This study aimed to investigate the impact of worked examples on creative thinking within the GBL environment. Specifically, through an empirical investigation involving a sample of participants engaging in GBL activities both with and without worked examples, this study sought to determine whether worked examples significantly impact creative thinking outcomes. The insights gained from this study can help with the design and implementation of educational games. By integrating the principles of instructional support, educators can create more engaging and dynamic learning experiences in GBL environments (Lester et al., 2020). These enriched educational tools would then provide learners with a stimulating and supportive learning environments where they can not only develop but also apply their creative thinking abilities in solving problems and exploring new concepts, thus preparing them more effectively for the challenges of the modern world.

1.2. Theoretical Framework

1.2.1. Game-based Learning (GBL)

According to Costikyan (1994, p.25), games are “A form of art in which participants, termed players, make decisions in order to manage resources through game tokens in the pursuit of a goal”. The essence of games and play has long been recognized as a critical element in human development (Plass et al., 2015). Recently, games are more widely implemented in educational contexts such as classroom settings and vocational training programs as it can adeptly integrate knowledge, construct authentic problem scenarios for learners, boost learning motivation, and efficiently foster student learning (Zheng et al, 2020). Accordingly, researchers defined GBL as the approach to utilize video games and associated elements such as game mechanics, content, subject matter, and imagery to enhance learning outcomes within the educational framework (Ge & Ifenthaler, 2018). For example, according to Trybus (2015), by utilizing well-designed games, learners engage with and practice applying problem-solving skills to reach specific learning goals. Furthermore, regarding its relation to creative thinking, a large amount of studies have showed GBL had an positive effect on improving students' creative thinking (Behnamnia et al., 2020; Gonzalo-Iglesia et al., 2018; Chen, 2023). The mechanism behind it might be that GBL environments can actively boost learning motivations and engagement (Cózar-Gutiérrez & Sáez-López, 2016), help users better absorb information and understand complicated systems to increasing users' creativity to create more innovative strategies for tackling obstacles quickly through both individual and collaboration (Prensky, 2003).

With the advancement of technology, GBL has increasingly been implemented in a technology-based manner. A case study conducted by Hsiao et al. (2014) demonstrated that students' creativity and performance underwent positive changes when they engaged in problem-solving within a GBL environment, which enhanced their creativity. Compared to traditional GBL, the multimedia and virtual reality characteristic of digital GBL environments provide easier access and record to information and avail better in knowledge delivering (Hsu et al., 2008)

Among all GBL environments, Minecraft stands out as a particularly popular game (Duncan, 2011) that requires players thinking of innovative strategies and utilizing diverse resources to pursue the goal of survival from the nature and enemies (Ekaputra et al., 2013). It encompasses exploration in an open-world virtual sandbox and allows for the creation of player-generated content, aimed at achieving goals related to survival and construction (Duncan, 2011). The game offers opportunities for diverse creative products to emerge, which contribute to nurturing various forms of creative expression and fostering the creative thinking process by going through a series of creative thinking processes (Blanco-Herrera et al., 2019). Beyond that, Minecraft: Education Edition is a specialized version of the popular sandbox game Minecraft, developed specifically for educational purposes. It was first released by the creators of Minecraft, in collaboration with educators and educational experts. The education edition offers a unique and engaging way to teach a wide range of subjects, providing students with hands-on learning experiences in a virtual environment.

Since its release, the Education Edition of Minecraft has been widely used in educational settings and has proven to be advantageous in pedagogical contexts. Cózar-Gutiérrez and Sáez-López (2016) conducted a research that incorporated Minecraft

Education Version for the initial teacher training in social sciences, and found that the participants utilized and valued Minecraft Education Version in pedagogical contexts with statistically significant improvements in engagement, learning motivations, and educational innovation. Besides, Minecraft was also found promising to improve players' creative thinking skills. According to Blanco-Herrera et al. (2019), when players decide to start object creation within Minecraft, they typically go through a creative thinking process that involves three phases: generating ideas (ideating), evaluating and selecting the ideas they wish to pursue (evaluation), and then figuring out the means to bring those ideas to life (creative problem-solving). Moreover, in the study conducted by Melián Díaz et al (2020) aimed for improving spatial abilities and creativity in learning, Minecraft was utilized and demonstrated significantly positive outcome in the improvement of creative thinking. Fauzan et al (2018) also found that participants engaging in Minecraft showed higher brain waves and performed better in high-level thinking skills including creative thinking than in any other videos. As such, Minecraft, as well as the specified educational version, serves as a promising GBL environment to enhance players' creative thinking.

1.2.2. Creative Thinking

Creative thinking is an essential aspect of human cognition that has been the focus of extensive research in psychology and education (Beaty et al., 2016). There has been a large amount of the definitions of creative thinking since last century. This study follows one of the most acknowledged definition of creative thinking forwarded by Torrance (1966) as:

> "*A process of becoming sensitive to a problem, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypothesis about these deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results*" (p. 6).

Furthermore, three central indices of creative thinking of fluency, flexibility, and originality were put forward by researchers. The combination of these three indices have been commonly used as assessments for the creative thinking level (Ding et al., 2014). According to Atakaya et al (2022), fluency denotes the quantity of ideas generated in response to a given problem. Flexibility quantifies the diversity of conceptual categories encompassed by these responses. Originality indicates the novelty or uniqueness of the generated ideas. The Alternate Uses Task (AUT), created by Guilford (1967), works as a commonly used test to measure the above-mentioned creative thinking indices (Alhashim, 2020). In the AUT, participants are usually asked to generate diverse uses for a few selected everyday objects, and the scores of creative thinking levels will be calculated on the basis of the handed responses using a specified coding and scoring strategy tailored to the research needs.

However, according to Lim and Han (2020), creative thinking is a rather complex learning outcome that is hard to enhance as the nature of creative thinking is fluid and dynamic rather than solid and innate, necessitating instructional support to facilitate the enhancement. Instructional support is the guidance provided in various forms in the GBL environment and holds the power to foster deeper learning experiences, and allows learners to concentrate on the most striking parts of a learning scenario (Lester et al., 2020). A meta-analysis conducted by Wouters and Van Oostendorp (2013) summarized diverse types of instructional support such as reflection, pre-training, and worked examples, etc.

1.2.3. Worked Examples

Specifically, worked examples as one type of instructional supports in GBL environments were defined by Sweller et al. (1998) as a process that concentrates on identifying problems and connecting operators, such as solution steps, to assist learners in constructing generalized solutions or schemes. Worked examples have been proven effective in guiding users in the selection, organization, and integration of new information (Mayer & Moreno, 2003; Wouters & Van Oostendorp, 2013), and availing individuals in comparing their own ideas with the reference information, thus supporting learning (Leemkuil & de Jong, 2011). Futhermore, in a study conducted by Tsai (2019) where worked examples were employed to enhance students' creative thinking, the findings revealed that the utilization of worked examples significantly improved the efficiency of generating creative ideas. This could be because worked examples could effectively mitigate cognitive load during learning to save time on the idea development and foster creativity in problem solving process (Shen & O'Neil, 2006; Tsai, 2019). However, to maximize the effect of the instructional supports like worked examples, a set of design principles and guidelines must be taken into account (Fries et al., 2021).

1.2.3.1. Design of Worked Examples

Retention and transfer are crucial factors when assessing the effectiveness of instructional contents such as worked examples (Mayer, 2008). A well-designed instruction enables students to achieve high scores in recalling basic content (retention) and effectively apply the learned solution steps to similar (near-transfer) or dissimilar (far-transfer) problems (Mayer, 2008). The amount of support the worked example provided should also be well-balanced because providing excessive support may give the impression to the students that the task is too easy, whereas offering too little support can demotivate students who find the task too challenging, and both situations does harm to students' motivation and even creative thinking (Tuovinen & Sweller, 1999). Furthermore, Seifert (2004) proposes that students exhibit higher motivation levels when they believe they are capable of completing the task. As such, when designing the worked examples, the difficulty of the worked example has to be well-considered so that participants feel the task is feasible, and provide only the essential information to stay motivated while doing the task. What's more, it is advisable to omit extraneous details and focus solely on solution steps and problem states, which helps prevent an overwhelming burden on working memory (Oehme, 2019). Besides, the worked example should only provide participants with only the thinking process instead of actual ideas as a worked example should work as a process concentrating on identifying problems and connecting operations (Sweller et al., 1998). At last, the positioning of a worked example appears to be significant. According to Tuovinen and Sweller (1999), in an experimental context, it is recommended to present the worked example immediately before the task to prepare students for it. This avails students in applying the skills and actions required for the task, thereby enhancing their ability to perform effectively.

1.2.3.2. Guidelines for Designing Worked Examples

Well-designed instructional support like worked examples that follow reasonable guidelines can be beneficial for helping develop deep understanding and transferable knowledge (Fries et al., 2021). Researchers have created a selection of instructional support guidelines such as Cognitive Theory of Multimedia Learning by Mayer (2022), six instructional principles for worked examples by Shen and O'Neil (2006), and three critical facets of worked examples by ter Vrugte et al (2017)

1.2.3.2.1. Cognitive Theory of Multimedia Learning (CTML)

CTML, developed by Richard Mayer, combines the science of learning and instruction design, creating a framework for multimedia principles. CTML takes three main assumptions on how learners acquire information. First is the assumption of active processing, where individuals play an active role in learning. Second is the limited capacity assumption, where learners have limited cognitive capacity. The third is the dual channel assumption, where learning occurs through two independent channels for processing information (Mayer, 2021). Besides, when designing multimedia instructional messages, it is also crucial to consider how humans process information. Mayer (2021) more specifically distinguished three kinds of demands on cognitive capacity: (1) extraneous processing, (2) essential processing, and (3) generative processing and associated principles such as coherence, spatial, and personalization principles. The sum of all three capacities "cannot exceed the learner's cognitive capacity" (Mayer, 2021, p. 67).

Multimedia Principle

The core of CTML is multimedia, which states that materials should be presented using words and pictures so that learners can learn better than when presented in words alone (Mayor, 2002). This means content, including instructional messages, should use words and pictures.

Minimizing Extraneous Processing

Mayer emphasizes the importance of minimizing extraneous processing, which refers to unnecessary mental activities that do not contribute to the instructional goal (Mayor, 2021). To achieve this demand, it is advisable to apply the coherence principle, which stresses eliminating unnecessary material to allow participants to focus on the critical steps without unnecessary cognitive burden (Mayor, 2002).

Managing Essential Processing

Essential processing contains the cognitive activities required to understand and represent the material in working memory (Mayor, 2021). This demand is directly tied to the complexity of the material being learned. In the worked example design, the information should be organized logically and structured by applying the spatial contiguity principle, temporal contiguity principle, segmenting principle, and the pre-training principle (Mayor, 2002).

Fostering Generative Processing

Generative processing refers to learners' cognitive activities to make sense of the presented material (Mayor, 2021). It is driven by the learner's intrinsic motivation to learn and understand the content. This can be achieved by applying the personalization principle in the worked example (Mayor, 2002).

1.2.3.2.2. Six Instructional Design Principles For Worked Examples

According to Shen & O'Neil (2006), there are six instructional principles that should be considered when designing a worked example: (1) Before vs. After that determines whether examples are presented before or after the learners attempt the task independently, (2) Complete vs. Incomplete that determines whether examples are fully or partially worked out, (3) Backward fading vs. Forward fading that refers to the gradual removal of support or guidance provided in the examples, either in a backward (starting with full guidance and reducing it) or forward (starting with minimal guidance and increasing it) manner, (4) Text vs. Diagrams that considers whether examples are presented in textual form, using words, or diagrammatically, using visual representations, (5) Visual vs. Verbal that determines whether examples are presented visually (using images, diagrams, etc.) or verbally (using text, spoken instructions, etc.), and (6) Steps vs. Sub-goals that determines whether the task is broken down into smaller steps or sub-goals to facilitate learning and understanding.

1.2.3.2.3. Three Facets For Worked Examples

Ter Vrugte et al (2017) stated that the worked example should contain the following three critical facets: (1) representation, (2) orientation, and (3) content. Table 1 presents a short summary of the three facets. The details of how these facets are incorporated in the design of the worked example will be elaborated in the method section.

Table 1

Three Facets for Designing Worked Examples by ter Vrugte et al.

Principles	Description
Representation	The manner in which information is presented
Orientation	The approach taken in presenting the worked examples
Content	The material covered within the worked example

1.3. Research Question

Despite the potential of worked examples in improving a deeper level of processing of organizing new knowledge and integrating with prior knowledge (Wouters, 2017), problem-solving skills (Shen & O'Neil, 2006), and learning motivations (Oehme, 2019), their role in specifically enhancing creative thinking in digital GBL environments remains underexplored. As such, the current study investigates the role of worked examples as instructional support to promote creative thinking in digital GBL environments, aiming to answer the following research question:

Research question: To what extent does the inclusion of worked examples have a significantly positive impact on the development of creative thinking in a digital GBL environment?

1.4. Scientific and Practical Relevance

Scientifically, the study contributes to the existing body of knowledge by investigating the effect of worked examples on creative thinking within a digital GBL environment. By exploring the effectiveness of instructional supports in fostering creative thinking, the study adds insights to the field of educational science and GBL. The findings also help advance theories and understanding of how instructional support, specifically the worked examples, can enhance creative thinking outcomes in educational settings.

Practically, the study has implications for the design and implementation of GBL environments and instructional practices. Understanding the role of worked examples in promoting creative thinking helps guide educators, instructional designers, and game developers create more effective learning experiences with necessary guidance and support that foster creative thinking. Moreover, the study's findings may be relevant for educational institutions and policymakers seeking evidence-based practices for integrating GBL and promoting creative thinking in educational contexts.

2. Method

2.1. Research Design

The current study employed a quantitative experimental research design with a control group and an experimental group to explore the impact of worked examples on the enhancement of creative thinking within a digital GBL environment. The independent variable was the presence or absence of worked examples, while the dependent variable was the participants' creative thinking outcomes measured by AUT, which was chosen for its established validity and reliability in assessing creative thinking (Alhashim et al., 2020). The experiment was conducted using the Minecraft Education Version where participants were tasked with two game tasks. The first task was centered on building a moat to protect players' virtual home from enemies to survive the night. A short introduction of the first task is presented in Figure 1.

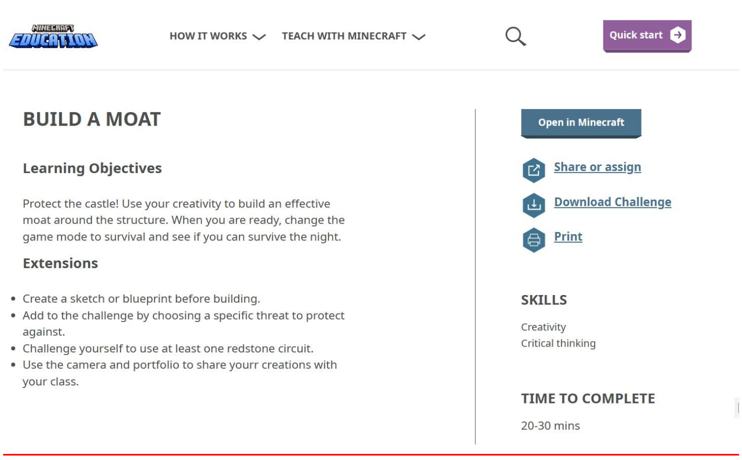

Figure 1. *Introduction of Minecraft Task "Build a Moat"*

The second task "Campsite" required players to construct a campsite using their creativity. Figure 2 gives a short description of the task "Campsite".

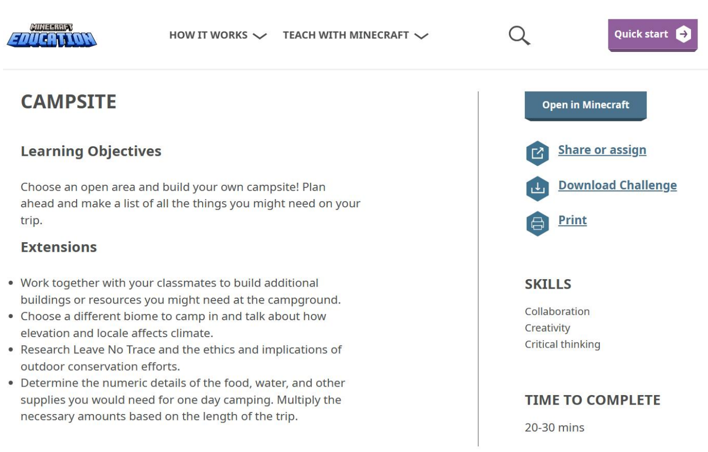

Figure 2. *Introduction of Minecraft Task "Campsite"*

These two building tasks were chosen as they are the existing tasks designed by Minecraft Education Version which exactly aim at improving players' creative thinking skills.

2.2. Participants

The participants for this study were university students who were recruited mainly using convenience sampling. Convenience sampling allows for efficient data collection without imposing significant time constraints or logistical challenges (Scholtz, 2021). Moreover, convenience sampling provides a reasonable representation of university students, who are the target population for the study. The credit recruiting system "SONA" from University of Twente (UT) was also used. SONA is a Behavioral Management Science (BMS) faculty recruiting system that enables UT students from BMS faculty to register, participate in the experiment, and also gain SONA credits. In this case, 2 SONA credits as incentives were allotted to students according to the evaluation result from the committee. All participants were informed of the anonymity and had given consent to the study.

A total sample size of 40 participants were divided equally and randomly between the control group and the experimental group, with 20 participants in each group. The recruitment process involved reaching out to students from relevant departments or courses, and via social media **(Appendix A)**. Eligible participants were university students with no or little prior experience with Minecraft Education Version. Prior to their participation, clear instructions and information about the study were provided, including the purpose, procedures, and any potential risks or benefits. Informed consent was obtained from each participant. Finally, 40 participants took part in this research and the demographic information is provided in Table 2.

Table 2

Demographic Information

Demographic	Participants
Total	40
Female	19 (47.5%)
Male	21 (52.5%)
Mean age	25.35

Prior Knowledge	
None	17 (42.5%)
Little/Low	23 (57.5%)

2.3. Measures and Instrumentation

In this study, the variables were operationalized as follows: the independent variable, worked examples, was operationalized by providing a sample of a house construction with step-by-step thinking process in Minecraft Education Version for participants in the experimental group (**Appendix B**). The dependent variable, creative thinking level, was operationalized by using the above-mentioned three central indices of creative thinking, which are fluency, flexibility, and originality. These three indices of creative thinking were operationalized as follows based on the literature review: Fluency was operationalized by counting the number of response generated by participants. Flexibility was operationalized by categorizing the ideas generated by participants into different conceptual categories. Originality was operationalized by assessing the novelty of ideas generated by participants (Atakaya et al., 2022). The dependent variable was measured at the interval/ratio level, with scores derived from the AUT.

The current study applied an existing eight-item scale for measuring creativity developed by Alhashim et al. (2020) for the established procedure for utilizing the AUT including coding and scoring. Participants were given twelve minutes to give as up to ten uses for each of the eight objects. There is one sample item provided and all eight items can been seen in Appendix C.

Sample - Please give as many as possible uses as you can for a foil.

2.3.1. AUT Coding Responses

To quantify the responses collected through the AUT tests, the responses were first coded based on a coding book (**Appendix D**) developed by the researcher adapted from Alhashim et al (2020). Responses from participants were categorized on the basis of the intended function or use described in the answers. Similar functions received corresponding codes, promoting consistency in evaluation. For example, “Door stopper” and “Keep bikes in place” were both coded as “Keep in place”. Additionally, responses that deviate from a functional context or lack coherence were deemed invalid and excluded from scoring.

To enhance the scoring reliability, a second coder was introduced to evaluate participants' responses alongside the primary coder. Both coders coded the responses of 10% of all participants (four participants in this study case) based on the code book. Then two coders collaboratively compared the results to resolve any coding conflicts, ensuring a unified and reliable scoring process. Inter-rater reliability analyses were performed to gauge the extent of agreement between the first coder and the second. In this case, Cohen's Kappa was employed to ascertain the inter-rater reliability score (Table 3). According to Chmura et al. (2002) , a kappa (κ) in the range of .61 to .80 indicates a substantial agreement. The inter-rater reliability analysis presented a reasonable level of agreement between the coders, affirming the reliability of the created coding scheme as a reliable assessment tool.

Table 3

Inter-rater Reliability Analysis

	Value	Approximate Significance
Measure of Agreement Kappa	.785	< .001
N of Valid Cases	313	

After all codes were established, the scoring process for each dimension commenced, providing a comprehensive evaluation of creative thinking.

2.3.2. AUT Scoring Creativity Dimensions

Based on the assigned codes, the fluency, flexibility, and originality were then computed for each item. The fluency score was derived by counting the total number of responses provided by the participants without considering the codes. For the flexibility score, the number of different approaches or categories presented by codes covered in the responses was counted. At last, to calculate the originality score, the frequency of each response was tabulated first. Then, frequencies and percentages of the codes were computed for each response. Such frequency and percentile ranking-based scoring strategy is commonly used by researchers when dealing with the indices of originality (Atakaya et al., 2022). When the probability of a particular code was smaller than or equal to 1%, it was assigned a score of 2 points. Codes with a probability more than 1% but less than or equal to 5% received 1 point, while those with a probability more than 5% were assigned 0 points. An example of the codes and assessment is given in Table 4.

Table 4

Example of AUT Assessment for the Item "Brick"

Responses	Code	Originality	Flexibility	Fluency
Building house	Construction	0	Code 1	Idea 1
Building campfire	Construction	0	Code 1	Idea 2
Smash things	Destroy	0	Code 2	Idea 3
Write something	Write	1	Code 3	Idea 4
Stand on to reach something	Stand on	1	Code 4	Idea 5
Play domino	Entertainment	2	Code 5	Idea 6
Hurt others	Weapon	0	Code 6	Idea 7
Net score for participants		3	6	7

After the score for each item was coded and computed, the final score for individuals was calculated. The final fluency score was the sum of eight fluency scores gained from each of the eight items; the total flexibility score was the number of different approaches or categories regarding all responses from all eight items as a whole; the final originality score was computed using the sum of the original scores from each item divided by the number of the total/final fluency score.

2.3.3. Worked Examples

Students in the experiment group received a worked example that was presented in a step-by-step format, employing clear and concise language to guide participants through the process of building a house using existing resources. To maximize the positive effect of the instructional support, the worked example designed and used in the current study followed the designing principles mentioned in the theoretical framework. The full worked example can be seen in **Appendix B**.

Generally, the worked examples in this study conformed to the characteristics: (1) being given before the activity, (2) being complete, (3) not including fading procedure, (4) using integrated text and diagrams, (5) using visual instruction, and (6) using steps.

In detail, the presentation, orientation, and content of the worked example are as follows:

For the representation (ter Vrugte, 2017), the worked example aligned with Mayer's (2002) Multimedia Principle by presenting information using both words and pictures. Each step was accompanied by textual explanations and associated images, facilitating better comprehension and cognitive processing. Furthermore, the principle of Minimizing Extraneous Processing was upheld by applying the coherence principle, streamlining information to eliminate non-essential details and reduce cognitive burden. This ensured that participants could focus on critical steps without unnecessary distractions.

In terms of orientation (ter Vrugte, 2017), the example adopted a product-oriented approach, emphasizing presenting the solution steps rather than delving into detailed reasoning behind each step. Thus, the reduction of reasoning explanation could minimize extraneous processing, mitigating unnecessary mental activities that did not contribute to the goal (Mayer & Fiorella, 2014).

Regarding content (ter Vrugte, 2017), the example focused on practical execution using common materials in Minecraft and simple actions to avoid overwhelming participants with theoretical or conceptual overload. Furthermore, the example fostered Generative Processing by applying the personalization principle, offering a digital, interactive, and self-paced learning experience. Instructions were presented in a conversational style, enhancing engagement and supporting learners' intrinsic motivation to interact with the material.

Additionally, to deal with the potential problem that the participants all had limited knowledge and experience in Minecraft, a video-formed pre-training part was designed for participants to familiarize themselves with the GBL environment. The pre-training video which was designed by the researcher gives participants insights about how to move, place, and dismantle items in the game.

2.4. Procedure

Prior to data collection, the study sought ethical approval from the Behavioral Management and Social Sciences Committee of the University of Twente, ensuring the adherence to ethical guidelines. University students were recruited as participants using convenience sampling. Random assignments were conducted to allocate participants to either the control group or the experimental group before the date collection phase.

During the data collection procedure, participants were first informed of the objective and design of the research, as well as research hazards such as 3D dizziness. They then filled out the consent form, which included information about the overall setup of the experiment. This included informing them about their rights regarding their data and ensuring them that all data would be handled anonymously.

Then, a questionnaire for the demographic information was given to the participants, collecting participants' nationalities, age, gender and familiarity for the game environment. After that, to establish the baseline creative thinking levels, all participants were asked to complete the AUT pre-test for up to 12 minutes before engaging in the game-based learning activity.

Before officially starting with the activity, all participants received pre-training on the basic functionalities of Minecraft which was designed to familiarize participants with the game mechanics, controls, and navigation within this GBL environment. After the training session, participants assigned to the experiment group received the worked example while those assigned to the control group did not. In the first game activity, both groups were given at most twenty minutes to complete the "Build a moat" task using Minecraft Education Version. After finishing the first task, the participants from the experiment group could have another access to the worked example to enhance the memory before starting with the second game task. The second game task "Campsite" also lasted for at most twenty minutes.

Following the completion of the two game-based learning activity, all participants underwent the post-test to assess their creative thinking levels after the intervention, from which the data were compared to gauge the change in creative thinking levels before and after the game-based learning experience. Figure 3 indicates the procedure per condition.

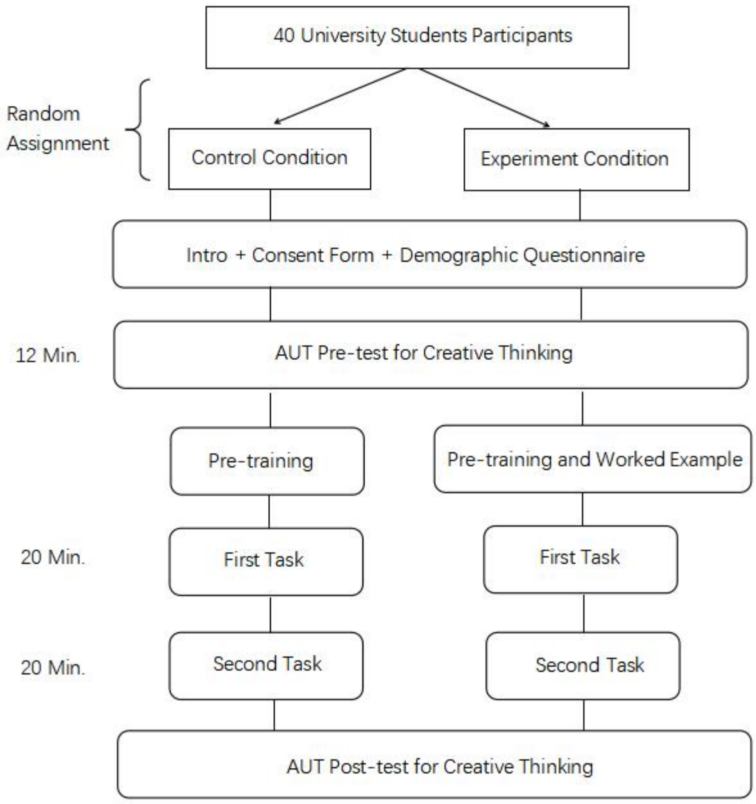

Figure 3. *The Procedure per Condition*

2.5. Data Analysis

The collected data for this study were analyzed using both qualitative and quantitative methods. The qualitative method was already mentioned above in the coding section, and SPSS version 29 was used for the quantitative analysis.

After all the responses derived from AUT were coded, descriptive statistics were calculated to summarize the participants' creative thinking scores. Descriptive statistics such as the mean, median, mode, and standard deviation were computed to provide a holistic overview of the data distribution and central tendencies, availing in understanding the average creative thinking levels of participants in both the control and experimental groups.

Then, inferential statistics were utilized to assess the impact of worked examples on creative thinking level outcomes. Firstly, the collected data were analyzed using a Paired-Samples T Test to compare the creative thinking outcomes within control and experimental groups, which could provide indications about whether the presence of worked examples had a significant positive impact on participants' creative thinking levels. The paired sample t-test is particularly useful when the same participants are measured twice, such as before and after an intervention, allowing researchers to determine if any observed differences are likely due to the intervention or have occurred by chance. In addition, a Multivariate Analysis of Variance (MANOVA) test was conducted to explore whether there were any significant differences between students in the two conditions in pre- and post-tests regarding different indices of creative thinking.

Before the inferential analyses, the requirements of paired-sample T-test and MANOVA test were checked. Shapiro-Wilk test was conducted to test the normality between paired observations and all p-values. Table 5 represents the result of Shapiro-Wilk test with all p-values greater than .001, indicating ideal normal distributions across paired observations.

Table 5

Wilk-Shapiro Test of Normality on Paired-Observations

	Shapiro-Wilk Statistic	***Significance***
Control Condition		
FluencyPre-FluencyPost	.95	.387
FlexibilityPre-FlexibilityPost	.95	.306
OriginalityPre-OriginalityPost	.97	.795
Experiment Condition		
FluencyPre-FluencyPost	.98	.924
FlexibilityPre-FlexibilityPost	.97	.800
OriginalityPre-OriginalityPost	.95	.400

Table 6 represents the result of Levene's test, and it demonstrated that all p-values of the three variables were greater than .001, showing that the error variance of the three dependent variable was equal across groups.

Table 6

Levene's Test of Equality of Error Variances on the Pre- and Post-test

	Levene Statistic	***Significance***
Fluency-pre	.002	.965

Flexibility-pre	.975	.330
Originality-pre	.000	.997
Fluency-post	.140	.710
Flexibility-post	.545	.465
Originality-post	.160	.691

Therefore, in this context, the collected data were deemed favorable as it suggested adherence to the underlying assumptions, enhancing the reliability and validity of the inferential analyses of paired-sample T-test and MANOVA test.

3. Results

3.1. The Improvement of Creative Thinking in the Control condition

Table 7 shows the statistics regarding the scores differences between pre-test and post-test in the control group for each of the three creative thinking indices: fluency, flexibility, and originality. As indicated in the table, the result suggests that the p-values for all three pairs, being greater than .001, indicating that there is no significant difference between the scores obtained in the pre-test and post-test for the control group. This implies that there were no significant changes observed in the measured variables over the course of the study period.

Table 7

Statistics for the Control Group

	M	*SE*	*T-value*	*P-value*
Fluency-pre - Fluency-post	1.00	.886	1.129	.273
Flexibility-pre - Flexibility-post	-.25	1.227	-.204	.841
Originality-pre - Originality-post	.06	.052	1.069	.298

3.2. The Improvement of Creative Thinking in the Experiment Condition

Table 8 shows the statistics regarding the scores differences between pre-test and post-test in the experiment condition for each of the three creative thinking indices: fluency, flexibility, and originality. The mean difference between fluency scores before and after participating in the designed GBL environment is 2.80 (*SE = 1.262, t = 2.219, p < .05*). For flexibility, the mean difference is .75 (*SE = .817, t = .918, p = .370*). And finally, for originality, the mean difference is .01 (*SE = .039, t = .160, p = .875*). In short, the results indicate a significant decrease in fluency scores from pre- to post-test for the participants in the experiment condition, with a mean difference of 2.80. However, for flexibility, there is no statistically significant difference observed. Likewise, for originality, there is no significant change observed. These findings suggest that being engaged in a GBL environment in which additional support in the form of worked examples was provided appears to have negatively influenced fluency scores, while having no impact on flexibility and originality scores.

Table 8

Statistics for the Experiment Group

	M	***SE***	***T-value***	***P-value***
Fluency-pre - Fluency-post	2.80	1.262	2.219	.039*
Flexibility-pre - Flexibility-post	.75	.817	.918	.370
Originality-pre - Originality-post	.01	.039	.160	.875

*Note. Significance levels: * p < .05*

3.3. Comparing the Control and Experiment Conditions in Pre-test

Table 9 presents descriptive statistics regarding participants' score differences for pre-test between two conditions for each indices of creative thinking and the results of pairwise comparisons for the three dependent variables. Each comparison contrasts the means between the control group (1) and the experiment group (2). For fluency, the mean difference between the two groups is 3.30 (*SE = 2.694, p = .228*). Similarly, for flexibility, the mean difference is 1.80 (*SE = 1.580, p = .262*). Finally, for originality, the mean difference is 0.05 (*SE = .057, p = .394*). Based on the result, the participants from the control group achieved non-significant higher scores in the pre-test in all three aspects than those from the experiment group.

Table 9

Pairwise Comparisons on the Pre-test

Dependent Variable	*(I) 1=Control 2=Experiment*	*(J) 1=Control 2=Experiment*	*Mean Difference (I-J)*	*SE*	*Significance*
Fluency-pre	1	2	3.30	2.694	.228
	2	1	-3.30	2.694	.228
Flexibility-pre	1	2	1.80	1.580	.262
	2	1	-1.80	1.580	.262
Originality-pre	1	2	.05	.057	.394
	2	1	-.05	.057	.394

Furthermore, the Box's Test of Equality of Covariance Matrices shows a p-value of .776, indicating that the observed covariance matrices of the dependent variables (fluency, flexibility, and originality) are equal across groups.

To determine the significance of the mean difference, a MANOVA test with Bonferroni correction was conducted to control for Type I error inflation due to multiple comparisons. With the application of Bonferroni correction, the value of Wilks' lambda for the condition was estimated at .950 (F = .625, p = .603), indicating non-significance. This suggests that the null hypothesis is accepted, indicating no significant difference between the control group and experimental group in pre-test scores when considering all dependent variables together. This aligns with the expectation of the study that there is no significant difference in the creative thinking levels before the use of the worked example.

3.4. Comparing the Control and Experiment Conditions in Post-test

Table 10 presents descriptive statistics regarding the score differences in the post-test across the control and experiment groups with/without the use of the worked example and the outcomes of pairwise comparisons for each of the three individual dependent variable separately, contrasting mean scores between the two groups. Significant differences were found between the groups for fluency and flexibility. Specifically, participants in the control group achieved significantly higher fluency scores of a mean difference of 5.10 (*SE = 2.412,* *p < .05*) and flexibility scores of a mean difference of 2.80 (*SE = 1.337, p < .05*) compared to those in the experiment group. However, there was no significant difference found in originality scores between the two groups with an extremely minimal difference close to .000 (*SE = .047, p = 1.000)*. In summary, participants in the experiment group exhibited significantly lower levels of fluency and flexibility compared to those in the experiment group after the use of the worked example, while no significant difference was found for the level of originality.

Table 10

Pairwise Comparisons on the Post-test

Dependent Variable	***(I) 1=Control 2=Experiment***	***(J) 1=Control 2=Experiment***	***Mean Difference (I-J)***	***SE***	***Significance***
Fluency-post	1	2	5.10	2.412	.041*
	2	1	-5.10	2.412	.041*
Flexibility-post	1	2	2.80	1.337	.043*
	2	1	-2.80	1.337	.043*
Originality-post	1	2	3.553E-16	.047	1.000
	2	1	-3.553E-16	.047	1.000

*Note. Significance levels: * p < .05*

Additionally, the Box's Test of Equality of Covariance Matrices shows a p-value of .657, indicating that the covariance matrices of the three dependent variables display equality across groups, which suggests a consistent pattern of relationships among the variables between the groups. The outcome provided assurance that the assumptions underlying the inferential analyses, namely the equality of covariance matrices, was adequately met. Such conformity enhanced the credibility and robustness of the inferential findings derived from the statistical analyses.

For the result of multivariate tests, the Wilk's lambda showed a value of .874 (*F = 1.734, p = .177*) with the Bonferroni correction, indicating non-significance, meaning there was insufficient evidence to reject the null hypothesis that no difference between groups across all dependent variables considered together.

4. Discussion

This study aimed to explore the effect of worked examples on people's creative thinking level which was operationalized as fluency, flexibility, and originality within a digital GBL environment. In addressing the research question, 'To what extent does the inclusion of worked examples have a significantly positive impact on the development of creative thinking in a digital GBL environment?' findings indicated that the incorporation of worked examples in the digital GBL environment, specifically the Education Edition of Minecraft, had a negative effect on the fluency and flexibility dimensions of creative thinking. Additionally, there is insufficient evidence to suggest that the worked examples affect the originality dimension of creative thinking. In summary, the current study concluded that the inclusion of worked examples, at least in the manner incorporated in this study, not only fails to have a positive effect on creative thinking but can also hinder it across various dimensions. These results appear to contradict previous findings that suggest worked examples contribute to creativity (Tsai, 2019; Kulkarni et al., 2013).

A possible explanation for the decrease in fluency and flexibility among participants in the experimental condition is the "fixation effect". This phenomenon refers to a cognitive state where individuals become mentally "fixed" on previous knowledge, examples, or analogies (also known as stimuli) when engaging in creative idea generation tasks (Agogué et al., 2014). Despite explicit instructions to avoid fixating on specific examples, individuals still tend to concentrate on them, which can restrict their thinking and hinder creativity by limiting the exploration of alternative solutions or perspectives, and thus inhibit their ability to generate novel and diverse ideas (Ezzat et al., 2020). According to Ezzat et al. (2020), instructing individuals to avoid specific examples formulated with a high level of specificity unintentionally amplifies fixation effect. In contrast, directives to avoid common examples using a more abstract level of categorization lead to a notable increase in the quantity of creative ideas generated, effectively doubling the output outside the confines of fixation. The fact that the worked example designed and utilized in the current study has a high level of specificity may explain the decrease in the number (fluency) and variation (flexibility) of generated ideas.

Despite the specificity degree of the worked examples, the level of how restrictive/expansive the worked example is designed can also affect the fixation effect, further influencing originality (Agogué et al., 2014). "Restrictive" denotes a confinement within a limited range of possibilities without altering the definition or characteristics (for example, a normal house) of the object being designed. On the other hand, "expansive" indicates a transformation in the identity of the object through the addition of unforeseen attributes (for example, a flying house) to the original concept (Hatchuel, 2001). Agogué et al (2014) observed that the solutions suggested by participants using expansive examples exhibited greater levels of originality compared to those provided by participants exposed to restrictive examples. The fact that the current worked example is tasked with building a normal house, not adding any unexpected attributes, may explain the unexpected result on creative thinking, specifically the originality dimension.

Besides, Sio et al (2015) conducted a meta-analysis and found that the facilitative impact on novelty and quality (originality) was heightened when fewer and more unconventional examples were introduced. Offering a solitary and rare example might prompt individuals to transition from exploring various segments of the problem space to delving deeply into a specific and distant domain, thereby promoting the creation of innovative and high-quality ideas. Although the current study only employs a single example concerning building a house, it may be considered overly common for such building tasks. This familiarity with the example could possibly constrain participants' thinking, limiting their exploration of alternative perspectives or solutions (Dahl & Moreau, 2002). Examples demonstrating properties that typically do not correlate in real-world scenarios provokes higher levels of creative thinking (Marsh et al., 1996). Thus, introducing examples from more diverse or unconventional domains, such as architecture in extreme environments or historical reconstruction techniques could encourage participants to retrieve the knowledge in unexplored field and stimulate the generation of more original and innovative ideas (Sio et al., 2015).

Furthermore, the far analogy absent in the design of the current worked example may also account for the negative tendency in creative thinking. Researchers have found that far analogy, which refers to drawing comparisons or connections from sources characterized by a minimal degree of similarity with the present problem domain, a promising way to produce more (fluency and flexibility) creative ideas (Qiu & Shu, 2012; Hender et al., 2002), and notably novel (originality) ideas (Chan et al., 2011) compared to near or no analogy. According to the findings of Chan and Schunn (2015), far analogies are integrated within and contribute to cohesive sequences of conceptual exploration, potentially emphasizing the generation of progressively incremental steps within the conceptual space. This association with far analogies is correlated with an elevated rate of concept generation (fluency) compared to alternative concept-generating methods, and also facilitates the exploration of variations in concepts (flexibility).

However, the worked example designed and implemented in the current study is more of a near analogy design with the worked example task and the GBL tasks being both building activities with similar characteristics. Near-analogies, as opposed to far analogies, draw comparisons or connections from sources that share a higher degree of overlap with the current problem domain (Chan & Schunn, 2015). This decision was originally motivated by the desire to provide participants with examples that are directly relevant to the task at hand, thereby facilitating a clearer understanding of the problem context, offering familiar and tangible reference points that participants could readily grasp, thus minimizing cognitive load and potential confusion. However, the current design may have ignored the idea fixation effect and the impact of far/near analogy on creative idea generation, failing to achieve the ideal outcome.

Limitation and Future Direction

The current study investigated how worked examples can potentially improve the outcomes of digital GBL environments with regard to creative thinking and provides insights into the instructional design of worked examples. Despite the insights gained from this study, several limitations warrant acknowledgment, suggesting avenues for future research to address.

One limitation concerns the fixation effect, where participants may become fixated on specific examples provided, hindering their ability to explore alternative solutions and perspectives. Despite efforts to mitigate fixation, the high specificity of the worked examples may inadvertently amplify this effect, limiting the fluency and flexibility of generated ideas.

Additionally, the lack of expansiveness in the examples, focusing solely on building a normal house, may have restricted participants' exploration of more original and innovative ideas. Furthermore, the absence of far analogies in the worked examples may have limited participants' ability to draw connections from diverse domains, impacting their fluency, flexibility, and originality of creative thinking. Future research should address these limitations by incorporating more diverse and expansive examples, as well as exploring the impact of far analogies on creative idea generation within digital GBL environments

Another notable limitation of this study pertains to the choice of the digital GBL environment, specifically Minecraft, as the platform for delivering the worked examples. While Minecraft offers numerous advantages such as its immersive and interactive nature, which can enhance engagement and motivation, it also presents certain limitations that may have influenced the study outcomes.

Firstly, Minecraft, despite its popularity and versatility, is inherently constrained by its block-based construction mechanics and visual aesthetic. This constraint may have restricted the range of creative expression and problem-solving strategies available to participants, potentially constraining the scope of their creative thinking. Moreover, Minecraft's open-ended nature and lack of structured guidance may have led to variability in the ways participants engaged with the worked examples, potentially influencing their effectiveness. Although this study has implemented a pre-training video for the participants to get familiar with it, the pre-training only introduces some basic operations such as movement and placement in order to avoid excessive cognitive load which can potentially affect the creative thinking. Providing more structured scaffolding or guidance integrated with a reasonable amount of working memory within the game environment could help ensure that participants interact with the examples in a more uniform manner, thereby enhancing the consistency and comparability of the study results.

Additionally, the choice of Minecraft as the GBL platform may have introduced biases related to participants' prior familiarity or affinity with the game. Participants who are already experienced or enthusiastic Minecraft players may have approached the tasks differently compared to those who are less familiar in the game, potentially impacting their responses to the worked examples. Although the participants recruited in this study were already intentionally selected between those with no or a little prior knowledge of Minecraft, there could still be a huge difference between those with no knowledge and a little knowledge. This might be because Minecraft is a complicated game with enormous elements, it is noticed during the study that those with no knowledge of Minecraft usually spent much longer time browsing items they could use and getting familiar with basic operations, which make them go through relatively more cognitive processes. Thus, future research could explore alternative GBL platforms that offer comparable levels of immersion and interactivity while minimizing potential biases or cognitive load related to prior experience or preferences.

Furthermore, it was observed that participants who were unfamiliar with Minecraft often exhibited lower levels of interest and higher levels of anxiety when engaging with the game (Melián Díaz et al., 2020). This could be attributed to the cognitive overload experienced by these participants as they grappled with the complexities of navigating a new and unfamiliar virtual environment. Thus, the impact of participants' mood states, including their levels of interest and anxiety, on their creative thinking processes is an important area for future investigation. Recording participants' mood states before, during, and after their interaction with the GBL environment could provide valuable insights into how these affective factors influence their engagement with the worked examples and their subsequent creative performance. By assessing participants' mood states alongside their creative thinking outcomes, researchers can better understand the interplay between affective states and cognitive processes in the context of GBL.

In conclusion, the findings of this study indicate that the worked example can have a negative impact on learners’ creative thinking levels in GBL environment. Potential reasons and limitations were identified, including the fixation effect due to the specificity of examples, the absence of far analogies, and constraints associated with the chosen GBL platform. Future research should address these limitations by diversifying examples, exploring alternative platforms, and further considering the impact of participants' prior familiarity and mood states on creative outcomes.

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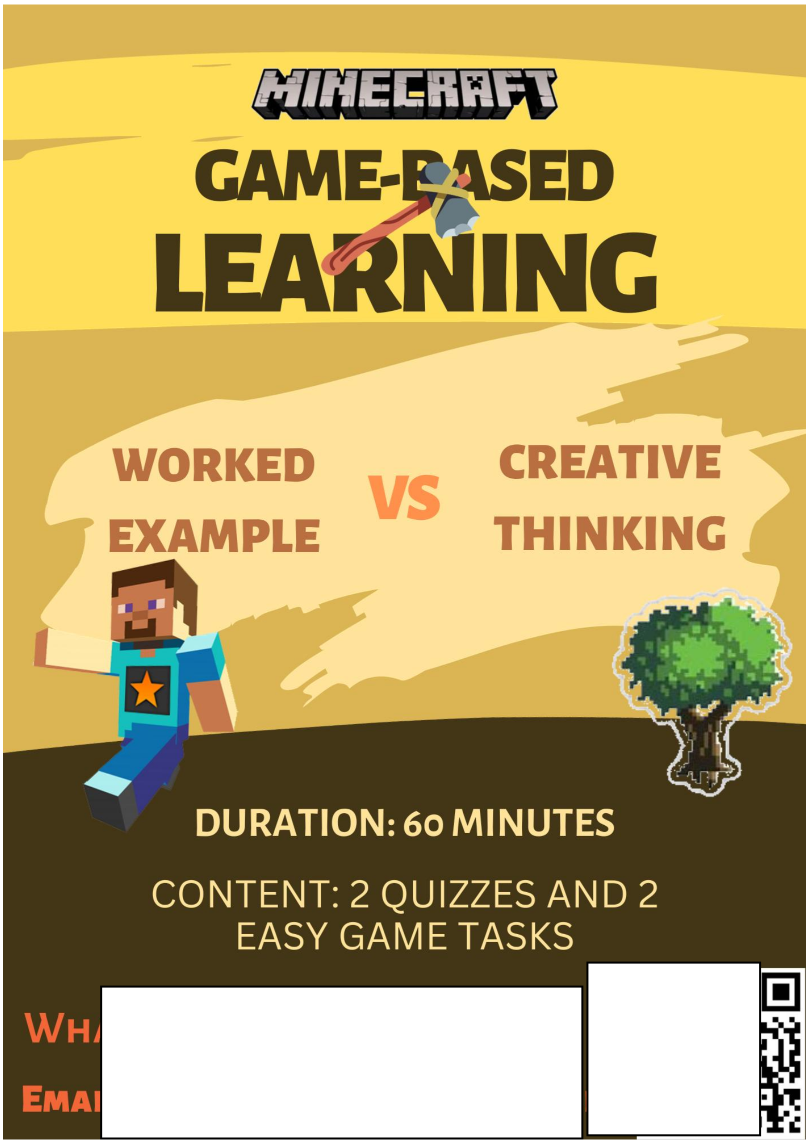
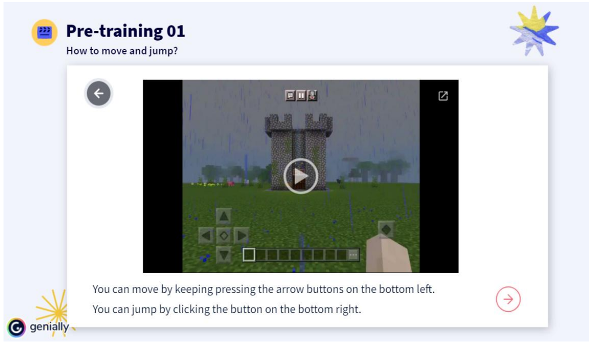
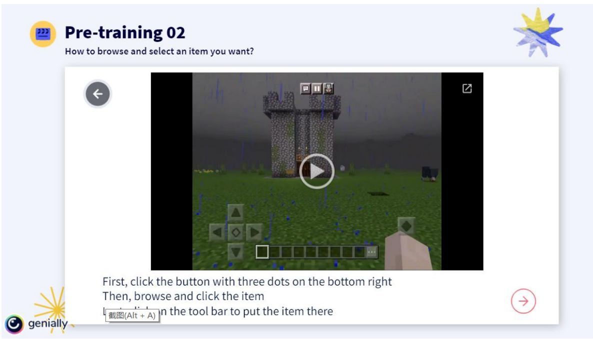
Appendix

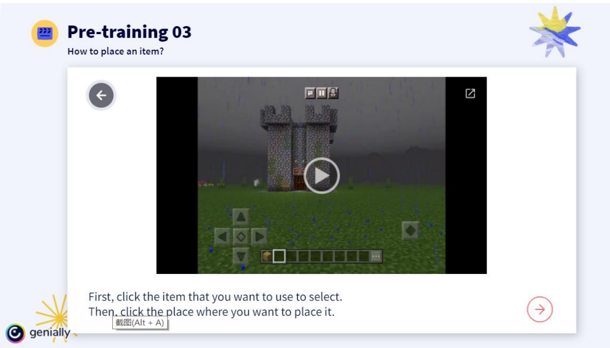
Appendix A - Flyer of Recruitment

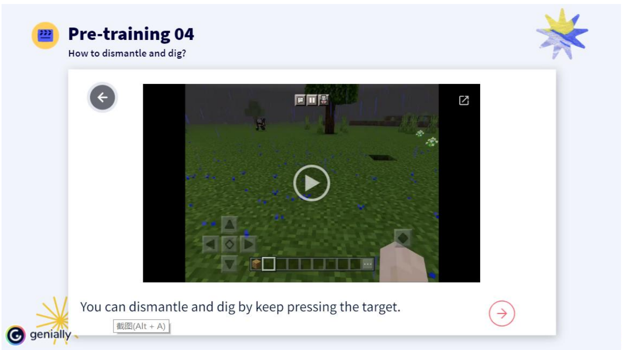


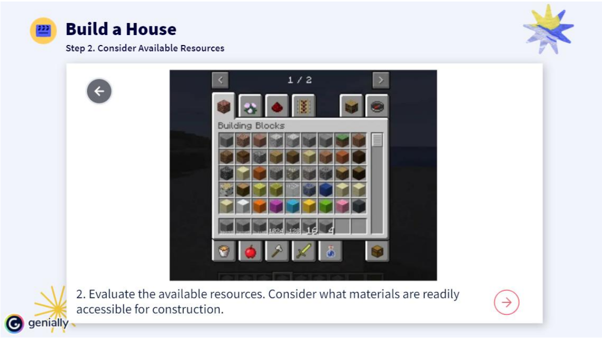
Appendix B - Pre-training and Worked Example

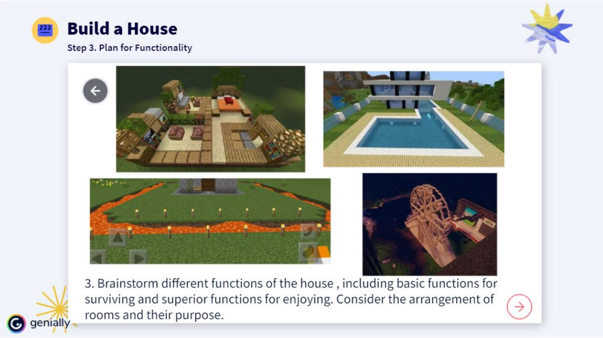


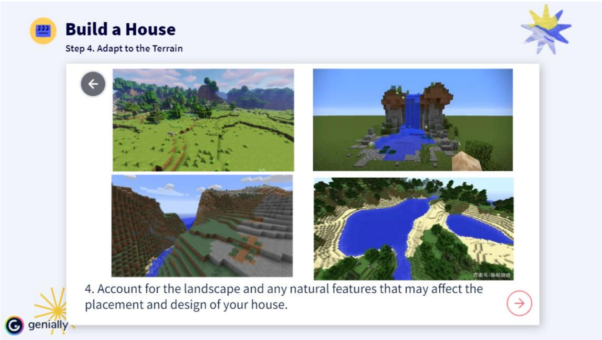


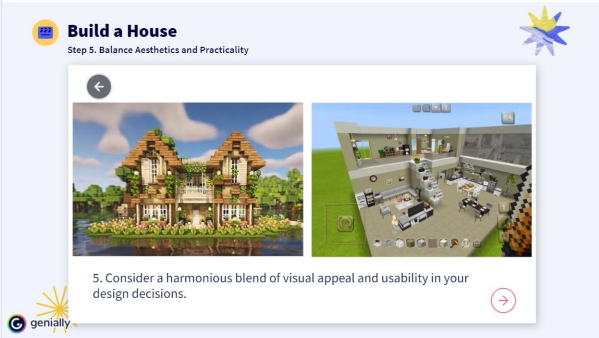





Build a House
Step 2. Consider Available Resources
1 / 2
Building Blocks
2. Evaluate the available resources. Consider what materials are readily accessible for construction.
genially


Build a House
Step 3. Plan for Functionality
3. Brainstorm different functions of the house , including basic functions for surviving and superior functions for enjoying. Consider the arrangement of rooms and their purpose.
genially


Build a House
Step 4. Adapt to the Terrain
4. Account for the landscape and any natural features that may affect the placement and design of your house.
genially


Build a House
Step 5. Balance Aesthetics and Practicality
5. Consider a harmonious blend of visual appeal and usability in your design decisions.
genially


Build a House
Step 6. Anticipate Future Additions or Changes
6. Leave room for expansion or modifications to accommodate potential future needs or preferences.
genially

Appendix C - Eight-item AUT

1- Please give as many as possible uses as you can for a foil.

2- Please give as many as possible uses as you can for a hanger.

3- Please give as many as possible uses as you can for a key.

4- Please give as many as possible uses as you can for a pipe.

5- Please give as many as possible uses as you can for a brick.

6- Please give as many as possible uses as you can for a helmet.

7- Please give as many as possible uses as you can for a magnet.

8- Please give as many as possible uses as you can for a pencil.

Appendix D - Code Book

Item	Category/Code	Description
Foil	Accessories	Miscellaneous items
	Art Supplies	Materials for artistic purposes
	Art/Decoration	Items for decoration or art
	Beauty	Products related to personal grooming and appearance
	Bedroom Essentials	Items essential for the bedroom
	Boil Back Tar Heroin	Code name for a specific item (needs clarification)
	Cleaning	Products or tools for cleaning
	Construction	Materials or tools for construction work
	Container	Items used for containing or storing objects
	Cooking	Items or tools for food preparation or cooking
	Energy	Products or items related to energy
	Entertainment	Items for leisure or entertainment
	Experiment	Equipment or items for conducting experiments
	Filter	Devices or materials for filtering substances
	Garment	Clothing items or accessories
	Hold Together	Items used to fasten or hold objects together
	Insulator	Materials that resist the flow of electricity or heat
	Kitchenware	Utensils or tools used in the kitchen
	Math Term	Mathematical terminology or symbols
	Money	Currency or financial items
	Personal Care	Products or items for personal hygiene or care
	Preserve Food	Methods or items for preserving food

	Protect	Items used for protection or safety
	Reflect	Items that reflect light or sound
	Scratch	Items for scratching or abrasion
	Set Microwave On Fire	Code name for a specific item (needs clarification)
	Sound	Items or equipment related to sound
	Stand On	Items that can be stood upon
	Tableware	Utensils or items for setting the table
	Transfer Liquid	Devices or items for transferring liquids
	Weapon	Instruments or tools used for combat or defense
	Weight	Items related to measurement of weight or mass
Hanger	Accessories	Miscellaneous items
	Art Supplies	Materials for artistic purposes
	Art/Decoration	Items for decoration or art
	Balance	Items or actions related to achieving balance
	Beauty	Products or actions related to personal grooming and appearance
	Cleaning	Products or tools for cleaning
	Close	Actions or items related to closing or sealing
	Communicate	Actions or items related to communication
	Container	Items used for containing or storing objects
	Cooking	Items or tools for food preparation or cooking
	Cutting	Actions or items related to cutting or slicing
	Destroy	Actions or items related to destruction
	Dry	Actions or items related to drying
	Energy	Products or items related to energy
	Entertainment	Items for leisure or entertainment
	Fan	Devices or items for creating airflow

Fishing	Activities or items related to fishing
Fly swatter	Device used to swat flies
Furniture	Items or pieces of furniture
Gift	Items given as gifts or presents
Hang	Actions or items related to hanging
Hold	Actions or items related to holding or grasping
Hold Together	Items used to fasten or hold objects together
Hook	Devices or items with a hook-like shape
Keep In Place	Actions or items used to keep something stationary
Make Holes	Actions or items used to create holes or perforations
Maneuver	Actions or items related to maneuvering
Material	Raw materials or substances
Medical Procedure	Actions or items related to medical procedures
Money	Currency or financial items
No Score	Indicates no scoring or evaluation
Open	Actions or items related to opening or uncovering
Outline	Actions or items used to create an outline
Pirate Hook	Hook typically associated with pirates
Reach	Actions or items related to reaching
Room Look Messier	Indicates making a room appear messier
Scratch	Actions or items related to scratching or abrasion
Sound	Items or equipment related to sound
Stir	Actions or items related to stirring or mixing
Take Up Space	Actions or items that occupy space

	Tool	Devices or items used for specific tasks
	Unclog	Actions or items related to unclogging
	Unlock	Actions or items related to unlocking
	Weapon	Instruments or tools used for combat or defense
Key	Accessories	Miscellaneous items
	Art Supplies	Materials for artistic purposes
	Art/Decoration	Items for decoration or art
	Bait	Substance used to attract animals for capture or observation
	Be replaced	Indicates an item needs replacement or substitution
	Beauty	Products or actions related to personal grooming and appearance
	Bird House	Structure designed for birds to nest in
	Car Key	Key used to start or operate a car
	Communicate	Actions or items related to communication
	Cutting	Actions or items related to cutting or slicing
	Destroy	Actions or items related to destruction
	Dig	Actions related to excavating or digging
	Energy	Products or items related to energy
	Entertainment	Items for leisure or entertainment
	Gift	Items given as gifts or presents
	Information	Items or actions related to conveying information
	Make Holes	Actions or items used to create holes or perforations
	Maneuver	Actions or items related to maneuvering
	Material	Raw materials or substances

	Open	Actions or items related to opening or uncovering
	Scratch	Actions or items related to scratching or abrasion
	Sharp Object	Objects with a sharp edge or point
	Sound	Items or equipment related to sound
	Symbol	Objects or representations with symbolic meaning
	Tool	Devices or items used for specific tasks
	Utensil	Tools or instruments used for eating or food preparation
	Weapon	Instruments or tools used for combat or defense
	Write	Actions or items related to writing or inscription
Pipe	Accessories	Miscellaneous items
	Art Supplies	Materials for artistic purposes
	Biomedical	Related to medical or biological applications
	Breathing Apparatus	Devices or equipment used for aiding breathing
	Cleaning	Actions or items related to cleaning
	Communicate	Actions or items related to communication
	Construction	Items or actions related to building or construction
	Container	Objects used for holding or storing items
	Destroy	Actions or items related to destruction
	Dig	Actions related to excavating or digging
	Elevation	Actions or items related to lifting or raising
	Entertainment	Items for leisure or entertainment
	Find Item	Actions related to searching for or discovering items

Gift	Items given as gifts or presents
Hang	Actions related to suspending or attaching
Kitchenware	Tools or utensils used in the kitchen
Magnification	Process or equipment for making things appear larger
Make Holes	Actions or items used to create holes or perforations
Paddle	Equipment used for paddling or rowing
Personal Care	Products or actions related to personal grooming
Pole	Long, slender object often used for support or propulsion
Protect	Actions or items related to protection or shielding
Reach	Actions or items related to extending or stretching
Sex	Actions or items related to sexual activity
Sharp Object	Objects with a sharp edge or point
Smoking	Actions or items related to smoking or tobacco
Sound	Items or equipment related to sound
Stir	Actions or items related to stirring or mixing
Support	Items or structures used for supporting
Tool	Devices or items used for specific tasks
Transfer Liquid	Actions or items related to moving or pouring liquid
Weapon	Instruments or tools used for combat or defense
Weight	Objects or equipment used for measuring weight
Write	Actions or items related to writing or inscription

Brick	Abrasion Tool	Tool used for grinding, smoothing, or polishing surfaces
	Art Supplies	Materials for artistic purposes
	Art/Decoration	Items or actions related to artistic expression or ornamentation
	Balance	Actions or items related to achieving equilibrium or stability
	Beauty	Items or actions related to physical appearance or aesthetics
	Block Something	Actions or items used to obstruct or impede something
	Communicate	Actions or items related to communication
	Construction	Items or actions related to building or construction
	Cutting	Actions or items related to severing or dividing
	Destroy	Actions or items related to causing damage or destruction
	Digging	Actions or items related to excavating or digging
	Elevation	Actions or items related to lifting or raising
	Energy	Items or actions related to energy or power
	Entertainment	Items or activities for leisure or amusement
	Exercise	Activities or equipment used for physical exercise
	Furniture	Items used for sitting, sleeping, or storage
	Garment	Articles of clothing or attire
	Gift	Items given as gifts or presents
	Hiding Spot	Locations or items used for concealment or hiding

	Home Accessories	Decorative or functional items for the home
	Keep In Place	Actions or items used to secure or stabilize something
	Material	Substances or elements used for making or constructing
	New Technology	Innovative or recently developed technology
	Symbol	Objects or representations with symbolic meaning
	Tool	Devices or implements used for specific tasks
	Weapon	Instruments or tools used for combat or defense
	Weight	Objects or equipment used for measuring weight
	Write	Actions or items related to writing or inscription
Helmet	Accessories	Additional items or articles used for a specific purpose
	Art Supplies	Materials or tools used for artistic creation
	Art/Decoration	Items or actions related to artistic expression or ornamentation
	Breast Implant	Medical device used for breast augmentation or reconstruction
	Clearning	Typo: Corrected to Cleaning
	Cleaning	Actions or items related to cleaning or tidying up
	Construction	Items or actions related to building or construction
	Container	Object used for holding or storing items
	Doorstop	Object used to wedge a door open or closed
	Elevation	Actions or items related to lifting or raising
	Entertainment	Items or activities for leisure or amusement

	Furniture	Items used for sitting, sleeping, or storage
	Garment	Article of clothing or attire
	Money	Currency or monetary units
	Protect	Actions or items used for protection or safeguarding
	Sound	Auditory sensation or vibrations
	Symbol	Object or representation with a symbolic meaning
	Tool	Device or implement used for a specific task
	Utensil	Implement or container used for eating or cooking
	Weapon	Instrument or tool used for combat or defense
Magnet	Accessories	Additional items or articles used for a specific purpose
	Art/Decoration	Items or actions related to artistic expression or ornamentation
	Attach	To fasten or connect something to another object
	Attract Object	To draw or pull something towards another object
	Balance	To maintain stability or equilibrium
	Beauty	Quality or characteristic that pleases the aesthetic senses
	Black/Chalk-Board	Board typically used for writing or drawing with chalk
	Compass	Instrument for determining direction
	Construction	Items or actions related to building or construction
	Cooling	Process or action of reducing temperature

Destroy	To damage or ruin something irreparably
Disruption	Interruption or disturbance of a process or event
Door Lock	Mechanism used to secure or restrict access to a door
Energy	Capacity to do work or produce heat or light
Entertainment	Items or activities for leisure or amusement
Gift	Item given to someone as a present or token of appreciation
Hold	To grasp, carry, or support something
Hold Together	To keep parts of something firmly together
Horse Shoe	U-shaped metal shoe for horses' hooves
Keep In Place	To maintain something in a fixed position
Open	To unseal, uncover, or allow access to something
Outline	To draw or define the outer edge of something
Personal Care	Actions related to grooming or maintaining personal hygiene
Protect	Actions or items used for protection or safeguarding
Repel	To drive away or resist something
Rock	Solid mineral material forming part of the surface of the earth
Sound	Auditory sensation or vibrations
Stir	To mix or agitate with a circular motion
Surface	Outermost or topmost layer of something
Tool	Device or implement used for a specific task
Unwrinkle Paper	To remove or smooth out wrinkles from paper
Weapon	Instrument or tool used for combat or defense

	Weight	Measure of the heaviness of an object
	Write	To inscribe or mark symbols or characters on a surface
Pencil	Accessories	Additional items or articles used for a specific purpose
	Art/Decoration	Items or actions related to artistic expression or ornamentation
	Beauty	Quality or characteristic that pleases the aesthetic senses
	Behind Ear	Area located at the back of the ear or behind it
	Cleaning	Actions or items used for the removal of dirt or impurities
	Communicate	To convey or exchange information or ideas
	Construction	Items or actions related to building or construction
	Cutting	To divide or separate something into smaller parts using a sharp tool
	Description	Words or phrases used to portray or represent something
	Destroy	To damage or ruin something irreparably
	Dig	To break up and move earth or soil using a tool
	Energy	Capacity to do work or produce heat or light
	Entertainment	Items or activities for leisure or amusement
	Erase	To remove or eliminate something by rubbing or wiping
	Food	Substances consumed to provide nutritional support
	Gift	Item given to someone as a present or token of appreciation

Keep In Place	To maintain something in a fixed position
Make Holes	To create openings or perforations in a material using a tool
Maneuver	To move or control something skillfully or carefully
Material	Substance used to make or create something
Open	To unseal, uncover, or allow access to something
Reach	To extend one's arm or hand in order to touch or grasp something
Scratch	To mark or damage a surface with a rough or sharp object
Sharp Object	Tool or item with a pointed or cutting edge
Sound	Auditory sensation or vibrations
Support	To bear or hold up the weight of something
Tool	Device or implement used for a specific task
Unclog	To remove an obstruction or blockage from a passage or pipe
Utensil	Tool or implement used for a particular purpose, typically in a kitchen or household
Weapon	Instrument or tool used for combat or defense
Weight	Measure of the heaviness of an object
Write	To inscribe or mark symbols or characters on a surface