

PAPER

Exploring the Impact of Gamification on 21st-Century Skills: Insights from DOTA 2

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ABSTRACT

This study explores how gamification in DOTA 2 cultivates 21st-century skills (problem-solving, teamwork, communication, and critical thinking). It supports DOTA 2 as an immersive platform for skill development. The study investigated various sources, including player surveys, meticulous gameplay analysis, academic research reviews, and expert opinions. By synthesizing this evidence, the study sheds light on DOTA 2's potential to hone and refine abilities. Player surveys revealed individuals' acquisition of adaptability in dynamic situations, cultivation of strategic thinking abilities, and enhancement of effective team collaboration skills. An in-depth examination of gameplay unveiled discernible patterns of collaborative effort and cognitive processes aimed at resolving challenges resembling real-world situations. Existing scholarly literature substantiates these findings and highlights gaming's role in developing 21st-century competencies. The study emphasizes the potential implications of its results for stakeholders, such as educators, policymakers, and game developers, offering valuable opportunities for the practical application of gamification strategies. It sparks further investigation and exploration of unexplored research avenues. This study contributes to the growing body of literature recognizing gaming's substantial advantages in fostering crucial 21st-century skills.

KEYWORDS

gamification, 21st-century skills, skill development, education

1 INTRODUCTION

In our rapidly developing world characterized by swift technological progress, technology has assumed a paramount role in various sectors, including education [1] [2]. We can attribute the surge in the importance of technology to its profound impact on the aforementioned industries [3] [4]. Technology integration in educational settings is experiencing a notable increase, presenting a significant potential for improving the quality of learning [5]. Educational approaches have grown, combining various media and methodologies to create an engaging, interactive, and technology-driven learning environment [6] [7]. Researchers have developed various

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methods, including problem-based learning, online learning, blended learning [8], immersive learning [9], project-based learning, and gamification, to promote critical thinking [10], collaboration, and essential 21st-century skills [11] [12].

In today's dynamic world, individuals require competencies in critical thinking, problem-solving, adaptability, and creativity [13] [14], with soft skills often considered as significant as specific knowledge [15]. Despite initial concerns about potential adverse effects, gaming has emerged as an innovative way to develop these essential skills [16] [17]. Video games have become a popular [18] and interactive leisure activity worldwide [19–21].

The increasing trend in the number of articles indexed in Scopus with a timespan (2012–2022) that contain the words “skills” or “competences” and “games” in the title, abstract, or keywords (Figure 1) reflects the growing recognition of the importance of specific skills in today's rapidly changing world.



Fig. 1. Number of manuscripts related to skills and games in the scopus database

Experts say video games can help individuals develop skills such as problem-solving, critical thinking, communication, and collaboration [22–24]. This research looks at how playing games can improve 21st-century skills. We surveyed defense of the ancients (DOTA) players from various circles to collect their views, aiming to explore this topic in-depth. DOTA 2 is a famous multiplayer online battle arena (MOBA) game that has gained a massive following worldwide [25]. It is known for its complexity, requiring players to think strategically and work collaboratively with their team to achieve victory [26]. Thus, it presents a unique opportunity to explore the relationship between gameplay and the development of 21st-century skills.

This study considered literature sources, psychological perspectives, and expert opinions from multiple disciplines. We employed gameplay analysis, player surveys, academic research, and expert opinions to explore how DOTA 2 fosters 21st-century skills development for individuals through gaming and subsequent applications outside its walls. Our goal has been to identify which skills individuals develop through play that they later apply elsewhere, with our all-inclusive approach revealing any benefits of gaming for skill building.

1.1 DOTA 2

DOTA 2 is a popular multiplayer online battle arena game developed and published by Valve Corporation. The game is renowned for its depth and complexity, making it a strategic real-time strategy (RTS) game [27]. It is the sequel to DOTA, a mod

created by the community for Warcraft III: Reign of Chaos. DOTA 2 is free-to-play and provides many opportunities to experiment with new strategies and tactics [28]. While Mobile Legends is another beloved MOBA title, DOTA 2 stands out due to its more intricate and strategic gameplay, which requires a higher level of skill and experience. The game also has an expansive and vibrant competitive scene, with tournaments and leagues hosted by Valve Corporation and third-party organizations.



Fig. 2. DOTA 2 gameplay

DOTA 2 is only available on PC, where two teams of five players battle it to destroy each opponent's "Ancient," an ancient structure located within their opponents' bases. Each player chooses a unique hero character with different abilities and play styles before working closely with their teammates to gain experience, level up quickly, and earn gold to purchase items that enhance power while taking down enemy towers and defenses [29] [30] (see Figure 2).

DOTA 2 features intricate, skill-based gameplay that requires strategic planning, cooperative teamwork, and rapid responses. Professional DOTA 2 players regularly compete in tournaments with exorbitant prize pools. The most celebrated DOTA 2 tournament, "The International," is hosted annually by Valve Corporation and funded by the DOTA 2 community (Figure 3) [31]. Substantial rewards are available for the winners of these tournaments, making them highly sought-after events.

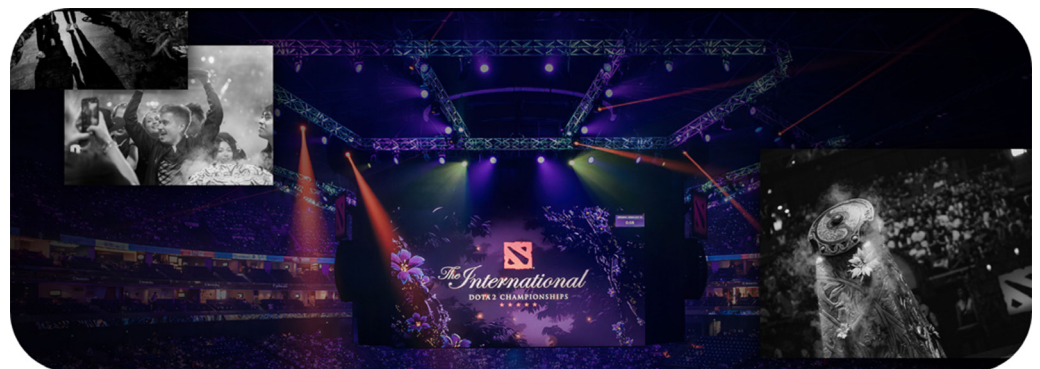


Fig. 3. The International DOTA 2

The International, one of the most prestigious tournaments in the esports scene, has seen its prize pool significantly increase in recent years, reaching over \$40 million in 2021 [32]. This growth has enabled some professional DOTA 2 players to amass millions in earnings from their competitive play. Notable players include Kuro “KuroKy” Salehi Takhasomi, Amer “Miracle-” Al-Barkawi, Johan “N0tail” Sundstein, Topias “Topson” Taavitsainen, Anathan “ana” Pham, Jesse “JerAx” Vainikka, and Sébastien “Ceb” Debs, who have all achieved great success in various DOTA 2 tournaments, including The International [33]. Through their dedication to honing their skills and strategies, these players have not only earned significant financial rewards but have also become notable figures in the DOTA 2 community, inspiring and motivating aspiring e-sports athletes to strive for excellence earn significant financial rewards, and pursue their dreams [34] [35]. (<https://www.youtube.com/@DOTA2>).

1.2 Twenty-first-century skills

Twenty-first-century skills encompass an array of abilities deemed indispensable for professional and personal achievement in today’s environment. These go beyond academic knowledge alone, including cultivating the competencies necessary to thrive in our rapidly advancing society [36–38]. Generally, experts have categorized 21st-century skills into four main groups: core academic skills, life skills, digital literacy skills, and career readiness skills [39] [40], as shown in Figure 4.

Core academic skills include traditional subject areas such as reading, writing, mathematics, and science, which are essential for many fields. Life skills refer to a wide range of capabilities required for personal and professional success, e.g., problem-solving, critical thinking, communication, collaboration, creativity, and adaptability [7]. Digital literacy skills are becoming increasingly important due to the significance of technology in present society, and include the capacity to use digital tools and resources, navigate digital platforms, and communicate effectively through digital media. Lastly, career readiness skills refer to the abilities necessary for success in the workplace, such as teamwork, leadership, time management, and professionalism [41] [42].

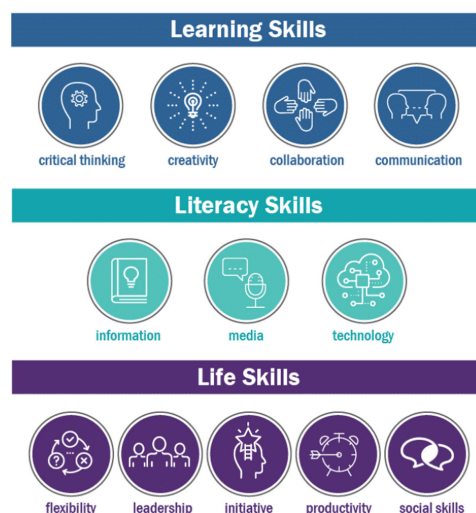


Fig. 4. Twenty-first-century skills

Playing video games, along with formal education and learning experiences in college, can help individuals develop 21st-century skills called the 4Cs (critical thinking, communication, collaboration, and creativity). Problem-solving, critical thinking,

communication, and collaboration skills, essential in the modern workplace and everyday life, can be developed through engaging video games [43] [44]. Playing team-based video games, such as DOTA 2, may facilitate the development of essential interpersonal skills, such as communication and collaboration, as players must work together to attain a common goal. Moreover, intricate mechanics and strategic aspects may stimulate problem-solving and critical thinking since players must assess the situation and make tactical decisions quickly. Furthermore, video games that integrate digital tools and resources can help cultivate digital literacy, which is increasingly indispensable in the contemporary, technology-driven era [45] [46].

1.3 DOTA 2 and skills

Academic studies have investigated the correlation between playing DOTA 2 and developing 4C skills. Sorman [47] conducted an in-depth investigation that concluded that playing DOTA positively affected university students' 4C skill development, particularly among players with higher experience levels. A separate study by Sedrick et al. [48] confirmed this result by concluding that playing DOTA can improve 4C abilities such as critical thinking and problem-solving capabilities; they suggested DOTA 2 players actively implement these capabilities when making strategic decisions and cooperate with team members to ensure successful gameplay.

A study conducted by Polman et al. [49] revealed that playing the online game DOTA 2 could improve university student's critical thinking, problem-solving, communication, and collaboration skills. This study included 300 participants who played at least one hour of DOTA 2 per day and compared their results to those of a control group of non-players. Results showed that players had better critical thinking skills [45] [50] and higher levels of collaborative problem-solving skills than non-players. Additionally, increased problem-solving abilities were associated with improved communication and collaboration skills, suggesting that playing DOTA 2 can enhance players' critical thinking, problem-solving, and interpersonal skills.

Overall, the studies suggest that playing DOTA 2 can benefit the acquisition of 21st-century skills such as critical thinking, problem-solving, communication, collaboration, and creativity [51]. Players with more experience playing the game tend to demonstrate improved 21st-century skills, suggesting that regular gameplay may facilitate the development of these skills over time [51]. The distinct gameplay mechanics of DOTA 2, which necessitate players to make strategic decisions and collaborate with teammates, may enhance these skills [29].

This paper explores the DOTA 2 video game's potential to develop 21st-century skills through comprehensive data collection, including player surveys, gameplay analysis, academic research, and expert opinions. Consequentially, it addresses several research questions. How do DOTA 2 players describe their skill-development experiences through gameplay? What patterns of teamwork, communication, and problem-solving emerge through gameplay analysis? What can academic research tell us about the potential benefits of DOTA 2 for developing 21st-century skills? By exploring these questions and sharing these findings with educators, policymakers, and game developers, this paper hopes to contribute to an expanding body of literature that acknowledges video games such as DOTA 2 as tools that foster 21st-century competencies.

2 METHODOLOGY

The research design utilized in this study adheres to a mixed-methods approach, integrating both quantitative and qualitative research methodologies.

This approach aims to thoroughly examine how DOTA 2 can foster the development of 21st-century skills. The research methodology employed in this study is an embedded design characterized by the concurrent gathering of both quantitative and qualitative data, with each type of data reinforcing the other. The supplementary data augments and strengthens the inferences derived from the initial data-gathering process.

The study used a rigorous recruitment process to target participants through online forums, social media platforms, and personal networks, including experienced players—eligibility criteria required at least six months of DOTA 2 gameplay and prior team experience. Multiple data collection methods were employed, including a player survey, gameplay analysis using Valve Corporation’s replay feature, academic research reviews, and expert opinions (Figure 5).

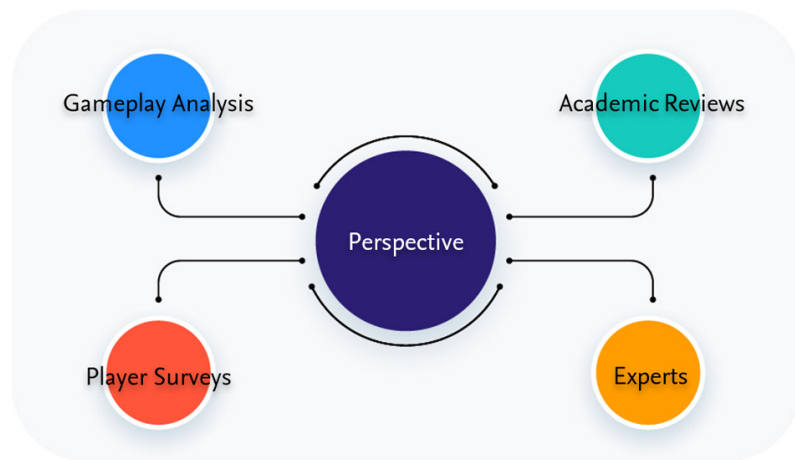


Fig. 5. Methodology

Gameplay analysis is crucial for understanding a video game’s mechanics, interactions, and potential improvements [52] [53]. It identifies strategies and tactics players can apply to real-world problem-solving through active observation and in-depth examination of gameplay footage [52]. This method helps developers identify areas for improvement and informs decisions regarding which features should be added or deleted (see: <https://www.youtube.com/watch?v=pSLfxEZVJVU>).

The player survey aimed to gather insights on problem-solving, communication, teamwork, and critical thinking experiences. Valve Corporation’s replay feature collected detailed gameplay data, which underwent qualitative content analysis to uncover meaningful patterns and themes. It incorporated academic research and expert opinions to enrich the study’s findings.

Integrating qualitative and quantitative data facilitated a comprehensive and holistic understanding of the relationship between DOTA 2 and 21st-century skill development. This mixed-methods approach enhanced the study’s validity and reliability by triangulating data from multiple sources, enabling researchers to gain deeper insight into the phenomenon under investigation. The findings provide valuable insights that can inform educational practices, policy-making decisions, and game development strategies in the context of skill development in the 21st century.

3 RESULTS AND DISCUSSION

3.1 Gameplay analysis

The in-game interface of DOTA 2 consists of several key components (Figure 6):

- 1) The item bar, which allows players to gain bonuses such as increased health, mana, movement speed, or damage;
- 2) The hero, which represents the player's character and contains attributes such as health, mana, and attack damage;
- 3) The map, which displays the current state of the game world, including the positions of all heroes and creeps, as well as essential locations such as towers, barracks, and the Roshan pit;
- 4) Skills, in which each hero possesses unique skills that they can actively use to attack enemies, heal allies, or perform other actions; and
- 5) Gold, which serves as the in-game currency and can be earned by killing creeps or enemy heroes or spent on items or hero upgrades.



Fig. 6. DOTA 2 in-game interface

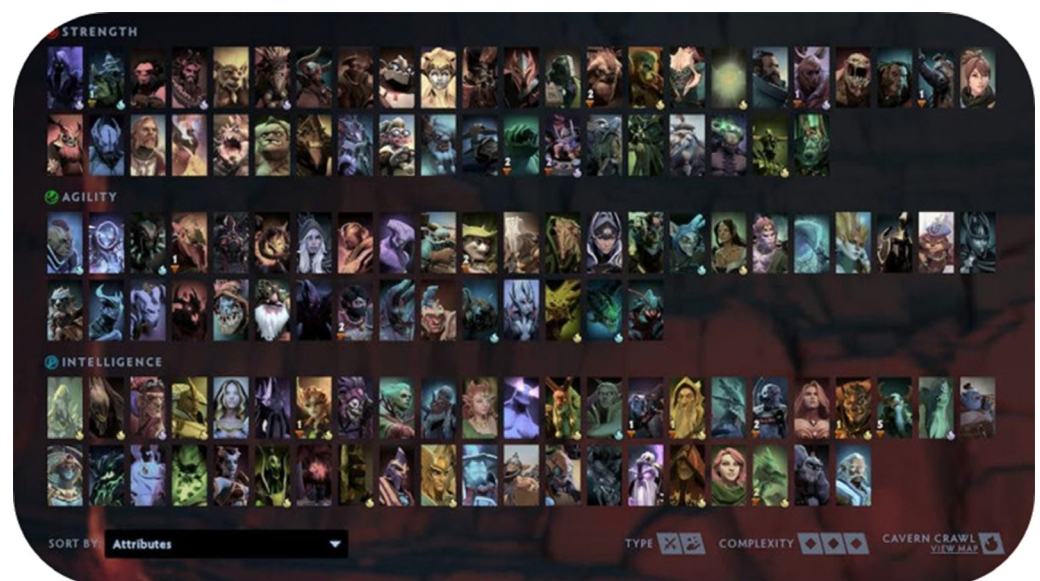


Fig. 7. DOTA 2 heroes

DOTA 2 involves players playing as different heroes (see Figure 7) with unique abilities and characteristics, competing in teams to destroy the opposing team’s base. Players can craft playstyles based on their strengths and preferences and can use items and abilities to enhance their hero’s capabilities or counter their opponents’ strategies [54] (see video: <https://www.youtube.com/watch?v=d6H-HEpnlk8>). This gameplay requires players to engage in high-level strategic thinking, decision-making, and teamwork, which are crucial in the 21st century and applicable in various contexts beyond gaming.

The complexity of Invoker in DOTA 2 has made him a favorite among experienced players (Figure 8). Invokers have three skill orbs main that can provide buffs and can be combined using his ultimate. With an intricate arsenal of spells at his disposal, Invoker can adapt to any battle situation. Each configuration of his three spell components yields of one of ten spells, meaning he’s never without a way to destroy or escape his enemies. As a result, they often regard Invoker as one of the most complex heroes in the game, offering a rewarding but challenging gameplay experience.



Fig. 8. Invoker’s ability in DOTA 2 gameplay

Players must coordinate with team members, communicate effectively, and work towards reaching a common goal. They need problem-solving skills to identify and overcome obstacles, adapt to changing circumstances, and make strategic decisions for victory. The match’s outcome affects the matchmaking rating (MMR), similar to how GPA reflects learning ability. An increased MMR indicates superior ability in DOTA 2. Thus, we can view it as an effective means for developing critical thinking and problem-solving abilities.

The relationship between MMR and 21st-century skills in DOTA 2 has been a topic of interest in the gaming community. MMR measures a player’s skill level in the game and reflects their ability to think critically and problem-solve in a fast-paced

environment (Figure 9). Players with higher MMR tend to better understand the game's mechanics, possess more effective communication skills, and exhibit superior decision-making abilities. Players improve by honing their critical thinking and problem-solving skills through their experience in the game.

Therefore, playing DOTA 2 at a higher MMR can help players develop and improve 21st-century skills essential in many aspects of life, such as work, education, and social interactions. It is important to note, however, that while MMR can be a good indicator of a player's skill level, it should not be the only measure of their abilities, as other factors such as game knowledge, situational awareness, and adaptability can also contribute to a player's success in the game. Only if the player is not using boosting services or purchasing high MMR accounts should it be noted that this applies.



Fig. 9. MMR DOTA 2

Studies have shown a positive correlation between players' MMR and 21st-century skills [47]. This correlation exists because DOTA 2 requires cognitive and social skills, including critical thinking, problem-solving, teamwork, communication, and adaptability. As players enhance these skills through playing DOTA 2, they can progress on the MMR ladder and face more formidable opponents who also possess these skills. Thus, the correlation between MMR and a player's 21st-century skills reflects the essentiality of these skills for success in the game.

DOTA 2, with its complex level of gameplay and a wide variety of heroes, items, and abilities, requires players to master its game mechanics, think critically, and adapt quickly in different situations. By immersing themselves in the captivating and demanding atmosphere of DOTA 2, players can hone their critical thinking abilities, including problem-solving, cooperation, and communication skills, thus contributing to their overall personal growth and development.

3.2 Players survey

This survey sought to explore the relationship between video game playing and 21st-century skill acquisition and to characterize respondents according to gender, age, weekly playing hours, years of experience playing, match ratings, and opinions regarding the benefits of games on problem-solving abilities and cognitive capabilities—the survey aimed to comprehensively understand the topic by collecting information from various game players.

The present study employed Colaizzi’s analytic method [33] to analyze the survey data collected from DOTA 2 players to explore the relationship between playing video games and developing 21st-century skills. This approach aimed to provide reliable and valid data analysis and draw accurate conclusions about the implications of playing video games.

Table 1. Distribution of respondents

Grade Level	Gender	Age	Total	Percentage
Junior High School	37 (M), 0 (F)	13–16	37	8.81%
Senior High School	157 (M), 0 (F)	16–18	157	37.38%
University	114 (M), 16 (F)	18–25	130	30.95%
Worker	91 (M), 5 (F)	18–40	96	22.86%
Total			420	100%

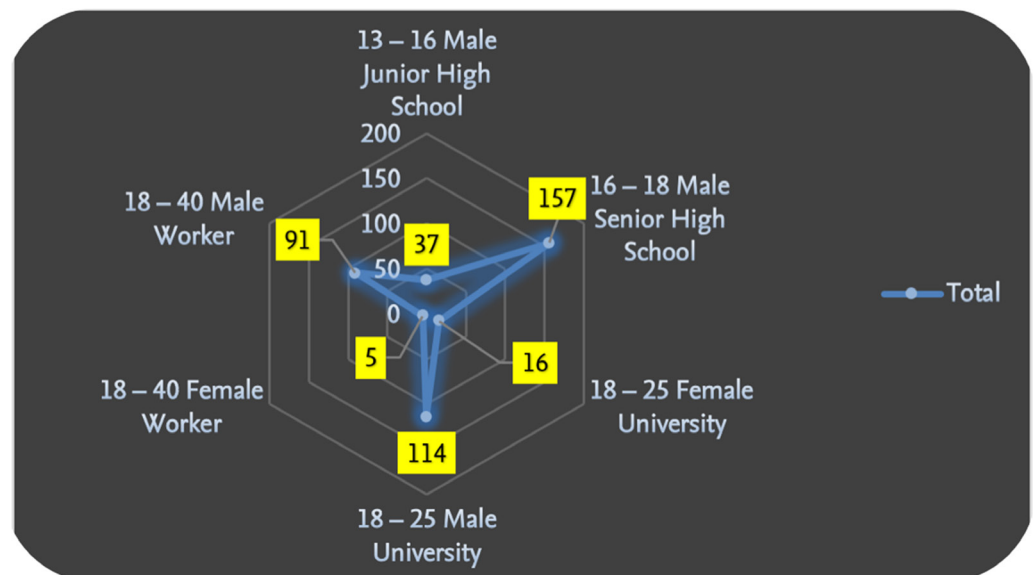


Fig. 10. Distribution of respondents

Based on the data provided in Table 1 and Figure 10, DOTA 2 is particularly popular among certain demographic groups, namely senior high school students, university students, and workers. Furthermore, there appears to be a gender-based discrepancy in the game’s popularity, as no female respondents from the junior high school and senior high school groups reported playing the game. In contrast, a small percentage of female respondents from the university group reported playing. These findings suggest that DOTA 2 is more likely to be

perceived as appealing to males than females, senior high school students, university students, and workers.

Six survey questions were administered to respondents to assess their perceptions of playing games' efficacy in developing 21st-century skills, as presented in Table 2.

Table 2. Survey questions

No.	Questions
1	How often is DOTA 2 played?
2	Is there a belief that playing DOTA 2 can improve 21st-century skills?
3	Which 21st-century skills do people believe playing DOTA 2 improves?
4	Has anyone ever applied 21st-century skills learned in DOTA 2 to real life?
5	Has anyone ever participated in competitive DOTA 2 gaming?
6	Which genre of video games is perceived to require the most skill?

How often is DOTA 2 played? Table 3 reveals that the frequency with which respondents played DOTA 2 varied depending on their educational background. Seventy-two respondents from senior high school, 41 from university, and 66 from worker backgrounds reported playing DOTA 2 once a week. Sixty-seven respondents from universities reported playing DOTA 2 several times a week. In contrast, the same number of respondents from senior high school and junior high school indicated the same frequency: 56 and 13, respectively. Several respondents from all educational backgrounds except workers indicated playing DOTA 2 daily (Figure 11).

Table 3. Question 1: survey results

Answer Choices	Respondents by Education	Total
A few times a week	Junior high school	13
	Senior high school	56
	University	67
	Worker	25
Every day	Junior high school	5
	Senior high school	7
	University	8
	Worker	0
Once a week	Junior high school	14
	Senior high school	72
	University	41
	Worker	66
Rarely	Junior high school	5
	Senior high school	22
	University	14
	Worker	5

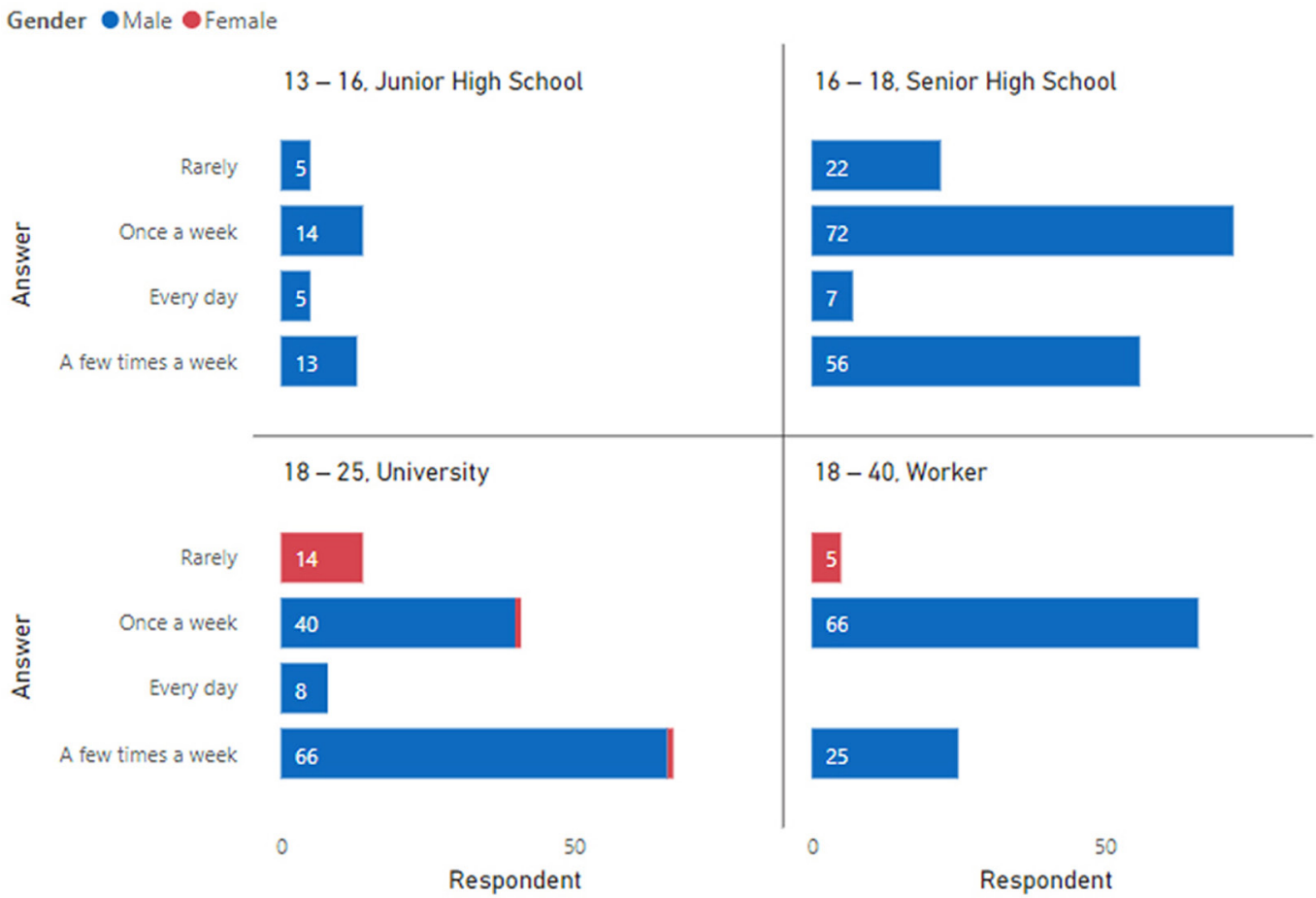


Fig. 11. Respondent by answer, gender, age, and education

Is there a belief that playing DOTA 2 can improve 21st-century skills? The data presented in Figure 12 in response to the question “Is there a belief that playing DOTA 2 can improve 21st-century skills? (e.g., critical thinking, communication, collaboration, creativity, and more)” indicates that out of the total respondents, 399 respondents, or 95%, believe that playing DOTA 2 can improve their 21st-century skills. In comparison, 21 respondents do not hold such a belief. The data suggest that many respondents believe that playing DOTA 2 can positively impact the development of 21st-century skills, including critical thinking, communication, collaboration, and creativity.

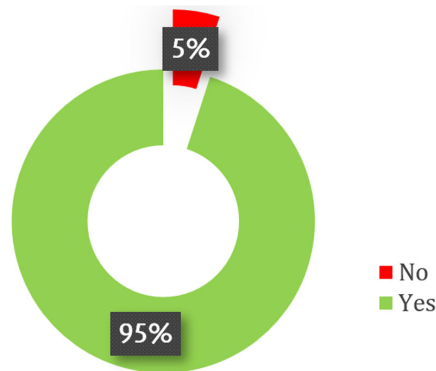


Fig. 12. Question 2: survey results

Playing DOTA 2 often involves working with other players, strategizing, and making quick decisions, which could enhance various cognitive and social skills. It is also possible that respondents who regularly play DOTA 2 have personally experienced the positive impact of playing the game on their 21st-century skills, leading to their belief that it can improve such skills. On the other hand, the small number of respondents who do not believe that playing DOTA 2 can enhance their 21st-century skills may hold this opinion for a variety of reasons, such as a lack of personal experience with the game or skepticism about the transferability of skills learned from playing a game to real-life situations.

Which 21st-century skills do people believe playing DOTA 2 improves?

Figure 13 shows the number of respondents who believe that playing DOTA 2 can improve six different 21st-century skills: (1) strategic thinking, (2) communication, (3) teamwork, (4) creativity, (5) problem-solving, and (6) adaptability. Of the total sample, 413 individuals (98%) believed that problem-solving was the most improved skill through playing DOTA 2. This necessity of making fast decisions and adapting to changing scenarios while playing the game could benefit problem-solving abilities.

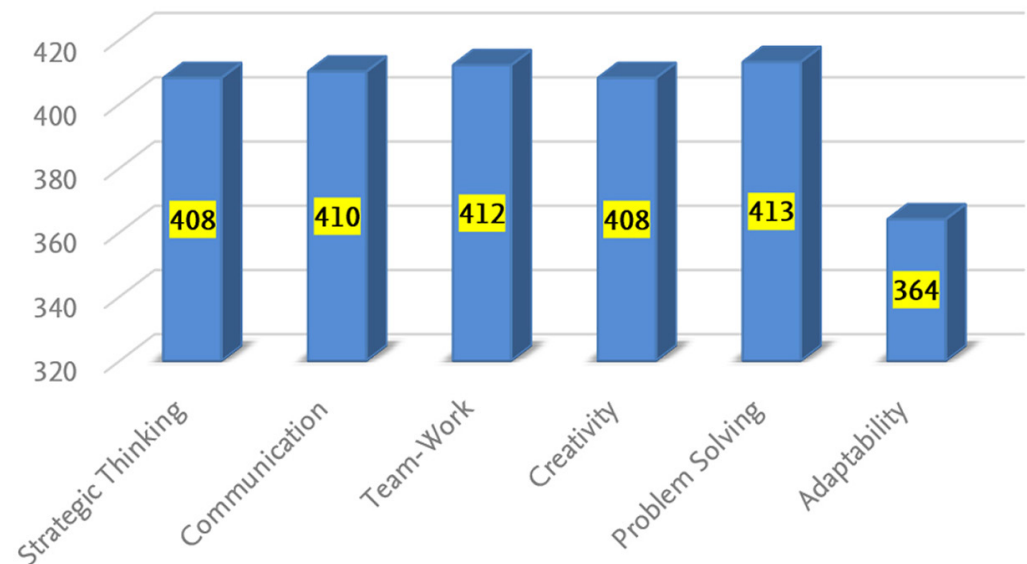


Fig. 13. Question 3: survey results

Research has demonstrated that playing DOTA 2 can improve communication, teamwork, strategic thinking, and creativity. Specifically, 410 and 412 individuals reported that communication and teamwork skills could be improved, respectively, while 408 said that strategic thinking and creativity skills could be improved. Playing DOTA 2 often involves working with other players to communicate strategies and develop creative solutions to overcome challenges. This positive impact may be one of the reasons behind the improvement it may have on players' 21st-century skills.

Finally, the data shows that 364 respondents believe playing DOTA 2 improves adaptability the least. This perception may stem from the game's requirement for players to constantly adapt to changing in-game situations. However, individuals may find it challenging to transfer the skill of adaptability developed in the game to contexts outside of gaming.

Has anyone ever applied 21st-century skills learned in DOTA 2 to real life? Data from Figure 14 indicates that 420 individuals from various age groups responded to whether they have applied 21st-century skills learned in DOTA 2 to real life. Participants were categorized as junior high school students (13–16 years old), senior high school students (16–18 years old), university students (18–25 years old), and workers (18–40 years old). The results showed that all age groups reported applying 21st-century skills learned in DOTA 2 to real life.

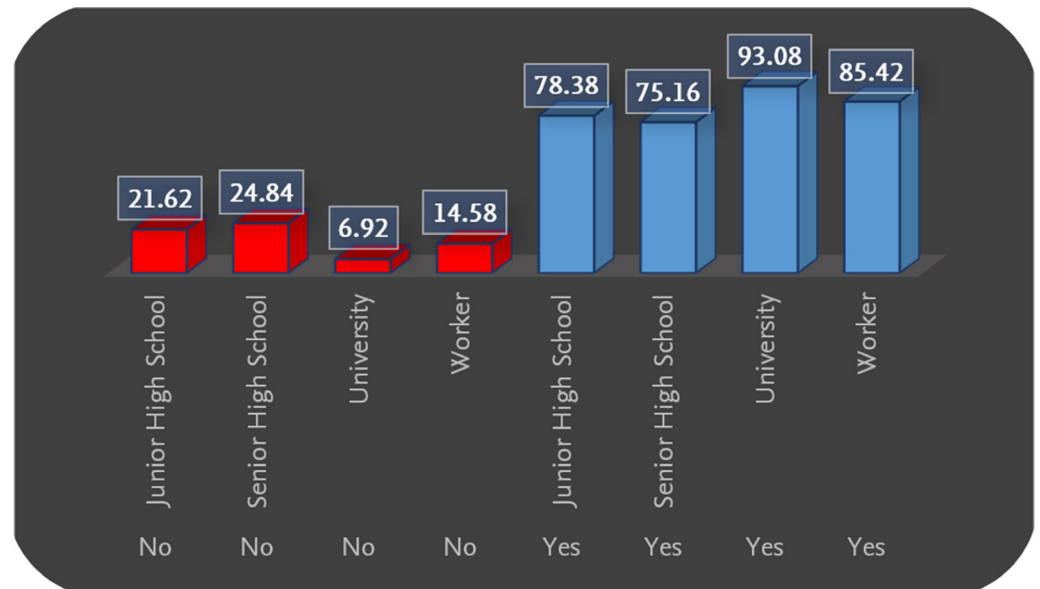


Fig. 14. Question 4: survey results

The data reveals that the university category had the highest percentage of respondents who answered positively (yes), with 93.08% claiming to have applied 21st-century skills learned from the video game DOTA 2 to their daily lives. DOTA 2 to their daily lives. The workers category also had the second-highest percentage of positive answers, with 85.42% of respondents claiming to have applied the skills. The junior high school category had the highest positive responses, with 78.38% claiming to have used the skills learned from the game. On the other hand, the senior high school category provided the lowest percentage of positive responses, with 75.16% of the total respondents. However, it is essential to note that this category also had the highest number of respondents, comprising 157 individuals.

This study’s findings indicate that most respondents (83.01%) reported applying the skills they learned from playing the video game DOTA 2 to real-life situations. These findings suggest that the skills acquired from playing video games have the potential for transferability, highlighting that individuals recognize the value of these skills. Further research is warranted to explore the specific skills respondents have found useful and how they have applied them in different contexts.

Has anyone ever participated in competitive DOTA 2 gaming? Based on the data gathered, most survey respondents have not participated in competitive DOTA 2 gaming. Specifically, out of the total sample of 59 respondents, only 13 (five from senior high school and eight from university) have participated in competitive DOTA 2 gaming, while the remaining 46 respondents have yet to. Among the education levels, the junior high school sample has the highest number of respondents (37) who have not participated in competitive DOTA 2 gaming (Figure 15).

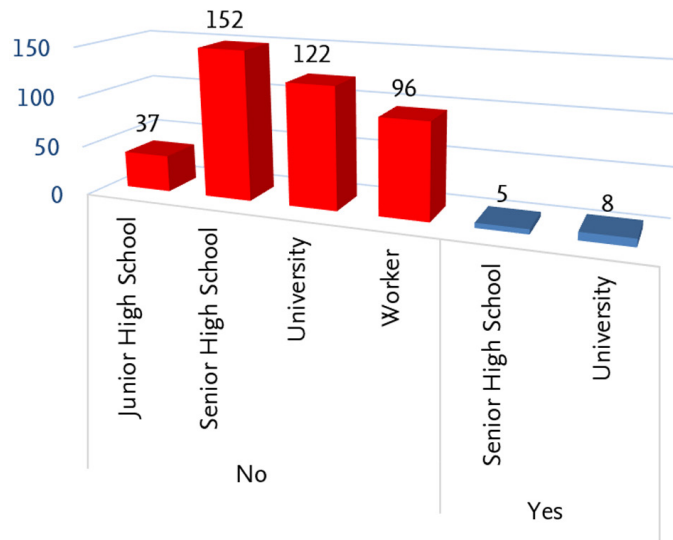


Fig. 15. Question 5: survey results

Which genre of video game is perceived to require the most skill? Results from a survey of 918 respondents revealed exciting perceptions about the skill requirements in different game genres. Strategy games were perceived to require the most skill, with 420 participants selecting this genre as their answer. One hundred ninety-six respondents considered racing games to have the second-most skill, while 188 respondents believed the same for sports games. In contrast, only 74 and 140 respondents selected fighting and shooter games as the genres requiring minor skills, respectively. These findings provide insights into the diverse perceptions regarding skill demands across various game genres.

The survey results (Figure 16) show that respondents perceive strategy games as the most skill-intensive video game genre, with most participants choosing this option. This perception stems from the complexity of decision-making, resource management, and critical thinking required in strategy games. On the other hand, fighting and shooter games require minor skills, with the lowest number of respondents choosing these options. This difference in perception may be due to the association between reflexes and hand-eye coordination in these games, which are considered less complex skills to master. Successful play in various video game genres demands the most skilled gamers in strategy games.

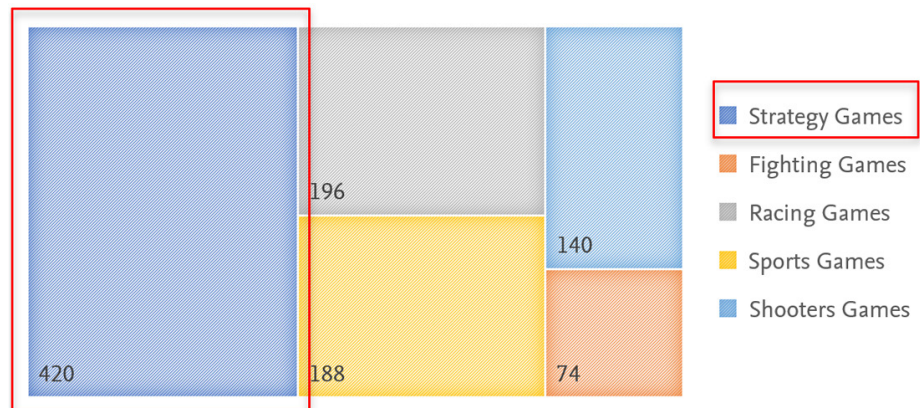


Fig. 16. Question 6: survey results

3.3 Game industry expert

Game industry experts hold diverse opinions regarding DOTA 2 but generally accept it as one of today's most successful and beloved MOBA titles. Research has shown that DOTA 2 has an exceptionally high skill ceiling, with a challenging learning curve that necessitates players to hone their game sense, decision-making capabilities, and teamwork aptitudes [55] [56]. The game's intricate mechanics and dynamic meta-game necessitate players to adjust and develop continuously, which can be a gratifying experience for committed players. As a result, DOTA 2 is a highly competitive and complex game that necessitates strategic thinking, teamwork, and problem-solving skills, which can benefit cognitive development.

Despite its steep learning curve and sometimes-toxic player community, DOTA 2 has made significant contributions to the gaming industry and has had a long-lasting impact, particularly in e-sports. The game's annual tournament, The International, is one of the world's most anticipated and prestigious events, with millions of dollars in prize money and millions of viewers watching the best players compete. Additionally, DOTA 2 has helped to popularize the MOBA genre and has influenced the development of many other games [57] [58].

Playing video games like DOTA 2 can positively and negatively impact students' psychological well-being [59]. On the positive side, playing video games can provide enjoyment, relaxation, stress relief [60], and a sense of accomplishment as players progress through levels and achieve goals within the game. In some cases, playing video games can also foster social connections and teamwork, as players collaborate and communicate. On the other hand, playing video games can lead to addiction, negatively affecting mental health and academic performance, such as neglecting other responsibilities, social isolation, depression, and anxiety. The impact of playing video games on students' psychological aspects depends on various factors, including the amount of time spent playing, the type of game played, and the individual's characteristics and circumstances. To promote overall well-being, students must balance playing video games with engaging in other activities, such as schoolwork, socializing, and physical exercise.

4 CONCLUSIONS

This study presents compelling empirical evidence supporting the notion that the widely popular video game DOTA 2 has the potential to enhance various 21st-century skills, with a particular focus on problem-solving, communication, teamwork, and critical thinking abilities. The findings above are consistent with previous studies that have illustrated the potential advantages of DOTA 2 in fostering skill enhancement. Engaging in the game DOTA 2 requires the utilization of strategic decision-making skills involving the selection of heroes and items, as well as fostering collaboration among players. Additionally, participation in DOTA 2 cultivates critical thinking abilities, problem-solving aptitude, and the development of creative thinking. Moreover, it has the potential to facilitate effective communication and foster collaboration among individuals.

DOTA 2 offers social interaction and stress relief, but maintaining the balance between gaming and other activities is crucial. Excessive gameplay can negatively impact academic performance and psychological well-being. Engaging in DOTA 2

can develop 21st-century competencies, emphasizing the importance of consistent gameplay and balancing gaming activities with other endeavors.

This study has a notable constraint in the restricted sample size, as it solely comprises students from a solitary university. Consequently, the findings may have limited generalizability to specific demographic groups. Moreover, it is important to note that the study had certain limitations in terms of its scope, as it solely focused on investigating the impact of DOTA 2 on 21st-century skills. As a result, this research did not examine other potential advantages, such as heightened self-assurance, enhanced problem-solving abilities, and increased creativity.

To enhance our comprehension of the impact of DOTA 2 on 21st-century skills, more extensive sample sizes and a broader range of populations are warranted in future research endeavors. Additionally, investigations should explore the influence of varying levels of gameplay on the development of skills and any potential advantages associated with DOTA 2, such as heightened self-assurance or enhanced problem-solving capabilities. Additionally, conducting a comparative analysis of the effects of digital technology on individuals in comparison to traditional activities such as board games or sports would yield valuable insights. Furthermore, exploring the potential of digital technology as an educational tool would be a particularly fruitful avenue of investigation.

5 RESEARCH IMPLICATIONS

This research has significant implications for multiple parties involved. The findings of this study emphasize the significance of DOTA 2 in fostering essential 21st-century skills, including critical thinking, problem-solving, communication, and teamwork. Educators and instructors can leverage this recognition to integrate video games into academic environments, fostering captivating educational experiences. Furthermore, this study emphasizes the transferability of skills acquired through engagement with DOTA 2 to real-world scenarios, thereby emphasizing its educational value as a medium for fostering skills beyond gaming. This body of knowledge has the potential to inform future research endeavors aimed at investigating the mechanisms underlying the dissemination and application of these skills across various domains. This study underscores the importance of incorporating a more comprehensive assessment of gaming habits and experiences in future research endeavors to investigate gameplay's role in skill acquisition and development. These implications contribute to the existing body of knowledge regarding the potential benefits of video games regarding skill acquisition and development.

6 AUTHOR CONTRIBUTIONS

Agariadne Dwinggo Samala: conceptualization, methodology, software, resources, gameplay analysis, data visualization, supervision, writing—original draft, writing—review and editing. **Ljubisa Bojic:** data analysis, validation, writing—review and editing. **Diego Vergara-Rodríguez:** gameplay analysis, methodology, validation, writing—review and editing. **Blanka Klimova:** data analysis, validation, writing—review and editing. **Fadhli Ranuharja:** gameplay analysis, resources, and investigation.

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