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The Fast-Thinkers Game as a Grade 12 accounting and mathematics interdisciplinary teaching and learning tool

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Background: Tertiary institutions require Grade 12 learners to have essential skills for accounting careers. The lack of these skills challenges South Africa's higher education system to produce workplace-ready graduates. This article introduces the Fast-Thinkers Game, a board game to enhance Grade 12 learners' accounting and math skills.

Aim: This article presents the development of the Fast-Thinkers Game, a board game-based learning (GBL) intervention designed to enhance the subject knowledge and skills of Grade 12 learners in accounting and mathematics.

Setting: The intervention was tested with 176 Grade 12 learners from Quintile 1–3 schools in the Free State province during the 2024 Free State Finance and Accounting Sector Education and Training and South African Institute of Chartered Accountants Development Camp.

Methods: Drawing inspiration from popular games, such as 30 Seconds and Monopoly, the study employed a quantitative research approach within the Design-Science Research framework. Learner perceptions were assessed through questionnaires containing both open-ended and closed-ended questions, using an open coding strategy for analysing qualitative data and SPSS software for analysing quantitative data.

Results: Results demonstrated that learners not only enjoyed the gaming experience but also improved verbal communication, reading, short-term memory, teamwork, engagement, and time management skills while gaining enhanced understanding of mathematics and accounting terminology.

Conclusion: These positive outcomes suggest the Fast-Thinkers Game represents a viable learning intervention for teachers and curriculum developers.

Contribution: This study provides a novel board GBL intervention that addresses essential skill gaps in Grade 12 learners, providing teachers with an engaging tool to enhance both subject knowledge and transferable skills necessary for tertiary education success in accounting programmes.

Keywords: accounting education; design-science research; game-based learning; mathematics education; interdisciplinary.

Introduction

Performance in Mathematics and Accounting in the Grade 12 National Senior Certificate (NSC) examination remains a concern in South Africa (Hendriks & Dunn 2021). They also stated that the issue is particularly significant given the increasing demand for chartered accountants (CAs) in the country and the persistent underperformance of Grade 12 learners in these subjects in recent years. According to Williams (2022) and Mafoso (2019), many learners enter their final school year lacking essential skills, such as basic calculations, critical thinking, reading, and writing, factors that contribute significantly to the disappointing Grade 12 Mathematics and Accounting results.

These skills are also critical for those aspiring to pursue a career in Accounting (Mafoso 2019). Accountancy programmes must meet the accreditation criteria and requirements of professional

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bodies, such as the South African Institute of Chartered Accountants (SAICA). The SAICA's 'CA of the Future Competency Framework' requires the development of 'Professional Values and Attitudes', 'Enabling Competencies (or Acumens)' (collectively referred to as Please provide the expansion '[PVAAs']). These PVAAs include various skills, such as communication, critical thinking, problem solving, among others. (SAICA 2025a).

In addition, studies that have focused on the success rates of learners in Accounting courses in their first year of university have indicated the necessity of these skills (Papageorgiou 2017; Bosua & Van der Nest 2015). A study by Kim, Lee and Suilkowski (2020) states that communication (specifically, reading) is a fundamental skill essential for success in academics and careers in today's information-centric society. Learners who enter university with weak reading abilities tend to face ongoing challenges during their tertiary studies. Part of the problem is that learners often read without comprehension. Shaffee et al. (2019) indicate that understanding the content is more important for learners than the language used to teach. Subsequently, learners need more opportunities to enhance these skills at the school level if they want to be successful in Accounting courses at university. With this background, the following research questions guide this study:

- *How can the Fast-Thinkers Game be adapted as a learning intervention tool for Grade 12 learners in mathematics and accounting during development camps?*
- *What are the perceptions of Grade 12 learners regarding skill development in mathematics and accounting after engaging with the Fast-Thinkers Game?*

Literature review

Taking deliberate interdisciplinary approaches to tackle problems enables learners to meaningfully merge and apply knowledge and skills from various fields (Lansiquot, Satyanarayana & Cabo 2014). It is assumed that interdisciplinarity promotes increased innovation rates. This fosters learners' capacity for innovative thought, enhances their problem-solving skills, and improves their adaptability to upcoming societal shifts (Zhou & Bakhir 2025).

Game-based learning (GBL) is an unorthodox way of learning and serves as a versatile tool, useful for teaching specific skills in Mathematics and Accounting education. Gamification is increasingly becoming a strong and innovative educational tool to motivate learners during the teaching and learning process (Silva, Rodrigues & Leal 2021). Gamification and GBL offer a unique way to engage theoretical knowledge in an enjoyable, motivating manner (Nørgård, Toft-Nielsen & Whitton 2017), encouraging active participation in both practical and theoretical aspects of education. Studies have shown that games can enhance enjoyment (Engels & Freund 2020), decision-making skills (Barba-Martín et al. 2020), and even be integrated with technology (Koekoek et al. 2018).

Recent studies have shown that the primary advantage of GBL is that learners enjoy themselves, especially their collaborative aspect and peer-to-peer learning (Ding & Yu 2024; Malan & Van Dyk 2021). Pelser-Carstens and Leendertz (2022) confirmed that GBL fosters engagement between learners and teachers, reinforcing social and academic relationships. The emphasis on student engagement in learning processes gained traction by using methodologies, such as GBL (Quintas et al. 2020). It seems that educational games, when used as a learning intervention, can generate high involvement and engagement in a social context (Carenys & Moya 2016). Lee, Shifflett and Downen (2019) found that active learners are deeply engaged with their educational materials and significantly involved in the learning process. Teamwork, enjoyment, and engagement, which are the benefits of GBL, seem to play a crucial role in the learning journey. Furthermore, GBL can serve as a tool within educational programmes to cultivate the pervasive and communication skills needed by professional organisations (Viviers 2016).

In the area of Mathematics, educational games were identified as suitable to promote mathematical achievements in various domains, for example, problem-solving and algebra skills, strategic and reasoning abilities, and critical thinking. However, GBL not only promote skills but also improves the performance of Mathematics (Che Mansor & Rosly 2024). As the mathematical performance of the learners improves, their motivation and engagement towards the subject also improve (Meylani 2025). Research has also been carried out on GBL in Accounting, and the majority has a positive outcome in terms of the improvement of skills and knowledge (Almuntsr et al. 2024; Koekemoer et al. 2023; Oktaviani 2024).

The idea of GBL includes leveraging actual games, such as Monopoly® and 30 Seconds®, to enhance the learning experience (Wiggins 2016). Malan and Van Dyk (2021) used two board games, Monopoly® and a modified version of 30 Seconds®, to explore learners' perceptions about developing pervasive skills in an undergraduate Accounting programme. Learners observed that the Monopoly® game primarily honed their strategic thinking, critical thinking, and professionalism, while the adapted 30 Seconds® game mainly improved teamwork, time management, and communication (including listening) skills. Enjoying the learning process was another benefit of the 30 Seconds® game, and learners considered both games to be effective educational interventions (Malan & Van Dyk 2021).

There is evidence in research that GBL provides opportunities and can be successfully used in education to address the improvement of critical thinking and problem-solving skills, social and communication skills, effective teamwork, and student motivation to master subject knowledge (Jordaan 2018; Romero, Usart & Ott 2015). The academic staff, mainly responsible for teaching the post-graduate programme in chartered accountancy at a South African university, used GBL and developed a board game, called the 'Post Graduate

Chartered Accountancy (PGCA) Fast-Thinkers Game' (Koekemoer et al. 2023), which was based on the actual 30 Seconds® game (Ultra Board Games 2022). Their research found that students perceived that the 'PGCA Fast-Thinkers Game' positively assisted them in developing the following skills: Communication skills, integration of subject 'languages', time management, short-term memory skills, comprehension of subject terminology and English language skills (Koekemoer et al. 2023). According to Qian and Clark (2016), GBL includes the adaptation of existing games to challenge players at different skill levels for different educational-related environments. This means that potentially, the 'PGCA Fast-Thinkers Game', designed for post-graduate accountancy students, can be adapted to be used as a learning tool to enhance accounting, mathematical, communication, reading and other related skills for Grade 12 school learners.

In 2024, only 36% of all the registered Grade 12 learners had Mathematics, with a national pass rate of 69.1% (a final mark above 30%). In the report of the Department of Basic Education (DBE 2024), these worrying numbers added to the debate of concern over the performance of Grade 12 learners, especially in Mathematics. Therefore, effectively, only 25% of all Grade 12 learners in 2024 obtained a pass on their NSC for Mathematics. These figures point to the urgent need for interventions aimed at reducing dropout rates in Mathematics and helping more learners achieve better results.

While previous studies have demonstrated that GBL can be successfully used in teaching and learning (Jordaan 2018; Pelser-Carstens 2022; Subhash & Cudney 2018), none of these studies have explored GBL as an interdisciplinary learning intervention in accountancy and mathematics teaching at the school level. More specifically, it appears that GBL has not been explored as a means to develop the skills of Grade 12 accounting and mathematical learners. The main purpose of this study is to investigate whether GBL, specifically the developed Fast-Thinkers Game (Koekemoer et al. 2023), can be adapted and used as a learning intervention in accountancy and mathematical teaching to develop skills with some success.

Theoretical framework

A research method regularly used for developing educational games is a design-based research method (Bell, Hoadley & Linn 2013; Kennedy-Clark 2013). This article will be guided by the Design Science Research (DSR) process. The DSR process aligns with experiential theory, combining action and reflection with theory and practice. This approach, through participation with others, provides practical solutions to problems in the education realm (Anderson & Shattuck 2012; Tang & Hanneghan 2014).

Research methods and design

This section provides an overview of the research process followed in this study. The mixed-methods research approach was applied using both a quantitative research method, showing trends and relationships, and a qualitative research method, providing in-depth perspectives (Creswell 2015). This approach was in line with the realistic and practical outlook of the researchers and was known as a pragmatic approach. By applying a convergent mixed-methods design where qualitative and quantitative data are collected simultaneously, the researchers cross-verified their findings to enhance triangulation and ensure a valid answer to a specific research question (Saunders, Lewis & Thornhill 2009).

Research design

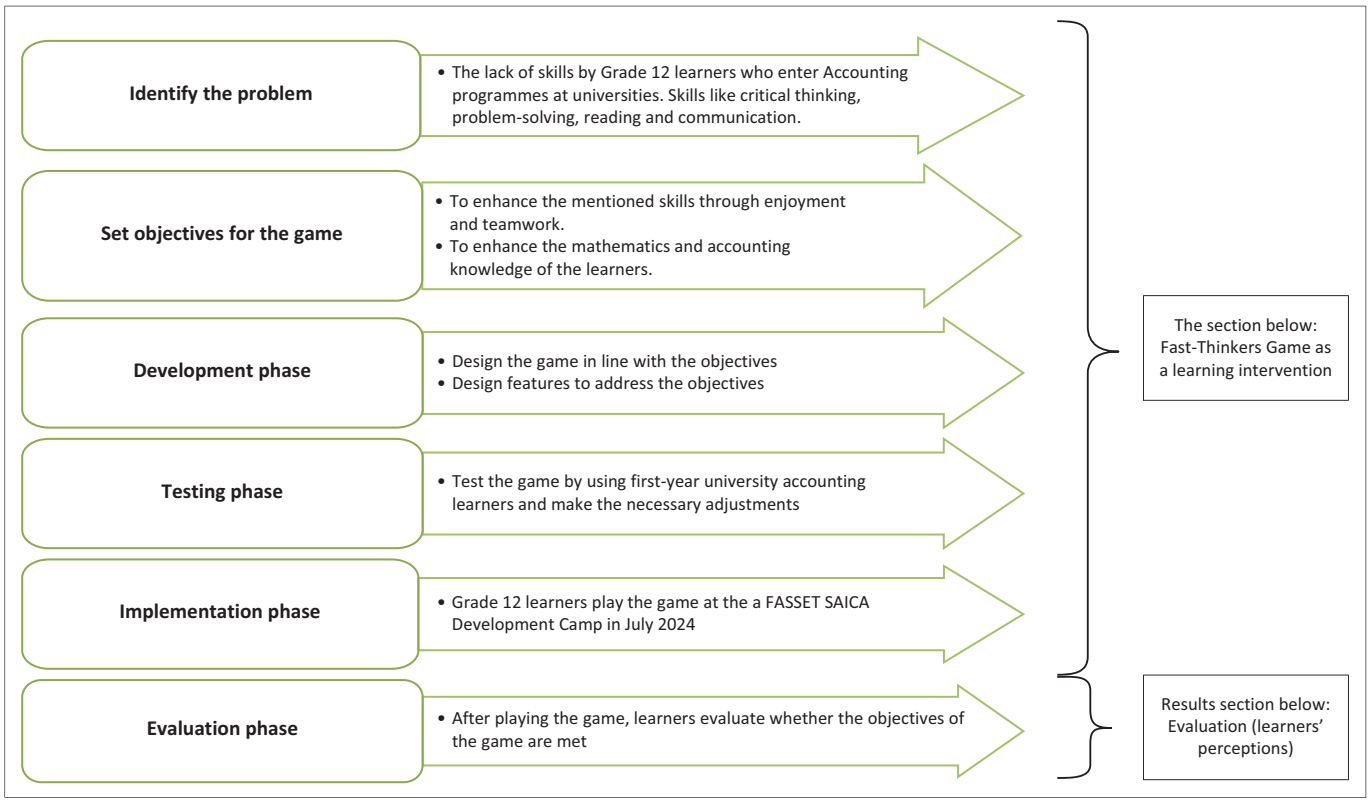
A design-based research method recommended by Pelser-Carstens (2022) is the DSR process. Pelser-Carstens (2022) developed the DSR process as a framework to be used to design games for learners that encompass pervasive skill development. When a DSR process is followed to design educational games, the design is conducted in an orderly manner using several phases. Although the phases in the DSR framework suggested by Pelser-Carstens and Leenderts (2022) are designed for games with digital components, the phases could also be used for designing old-school tabletop games, such as the Fast-Thinkers Game. As the DSR process was designed in the same context as this study, and it was used in the development of the related PGCA Fast-Thinkers Game (Koekemoer et al. 2023), the researchers decided on the DSR process as an appropriate design-based research method for this article.

According to Reubens (2016), a DSR process aims to construct a new reality for solving problems. The result of a DSR process can be a product, process, technology, tool, method, procedure, or a combination of these to achieve a purpose (Baskerville, Kaul & Storey 2015). In this article, the result is the Fast-Thinkers Game, a tool that might be used to enhance various skills among Grade 12 learners. The phases of the DSR process include identifying the problem, proposing satisfactory solutions as objectives for the game, developing the game mechanics by aligning the game with the objectives of the game, testing the game, an implementation phase, and, finally, an evaluation phase (Pelser-Carstens 2022). Figure 1 illustrates how the DSR process was applied in this article to design the Fast-Thinkers Game.

The first design phase in the DSR process (Figure 1) is to identify an existing problem and to illustrate the relevance of the problem (Pelser-Carstens 2022). The problem identified was the lack of skills and content knowledge by Grade 12 learners who enter Accounting programmes as a career path.

Set objectives for the game

The Fast-Thinkers Game aims to enhance and develop Grade 12 learners' accounting vocabulary, mathematical problem-solving skills, and other pervasive skills, such as communication and reading, which may positively affect the learners.



Source: Adopted and revised from Koekemoer, A., Goodchild, E., Rossouw, C. & Swanepoel, K., 2023, 'A board game as a learning intervention to enhance communication skills among post-graduate accountancy learners', *Southern African Accounting Association* 21, 107

FASSET, Free State Finance and Accounting Sector Education and Training; SAICA, South African Institute of Chartered Accountants.

FIGURE 1: Designing the Fast-Thinkers Game using the design science research process.

Development phase

The PGCA Fast-Thinkers Game (Koekemoer et al. 2023) was adapted to be relevant for Grade 12 learners, and a brand-new accounting and mathematical game (the Fast-Thinkers Game) was developed. The concept of how the game is played is described below, after the development of the game is outlined. In addition to enhancing learners' understanding of Accounting concepts and mathematical problem-solving skills, the research will also focus on developing their listening, reading, and communication skills. Furthermore, it is expected that the learners will have fun while learning.

The board game cards of the PGCA Fast-Thinkers Game included 100 terms or concepts from the four core modules of the post-graduate-chartered accountancy programme, namely Managerial Accounting and Financial Management (including Strategy and Risk), Financial Accounting (Accounting and External Reporting), Taxation and Auditing (including Governance and Ethics) (Koekemoer et al. 2023). Because the Grade 12 learners only have Accounting as a subject at the school level and not the four core modules as included in the PGCA Fast-Thinkers Game, the PGCA Fast-Thinkers Game was adapted by removing the four modules, and the only block (game cards) that remained relating to the theoretical terms, was Accounting. The terms on the Accounting cards were also changed. The 'Glossary of Terms' from the Grade 12 Accounting Textbook (Hall et al. 2022) was used as the terms included on the Accounting cards. As with the PGCA Fast-Thinkers Game, these terms were printed on a card. Each printed card contained five Accounting terms or concepts.

As universities require learners to have Mathematics at school to enter their Accountancy Programmes (SAICA 2025b), a mathematical component was added to the Fast-Thinkers Game. A word problem was printed on each card to design the mathematical cards. These word problems were obtained from numerous Mathematics past papers set by the DBE for Grades 9–12. Thus, the Fast-Thinkers Game for Grade 12 learners combines Accounting terms or concepts, which the players will explain, with solving mathematical word problems. The 'chance' blocks included in the PGCA Fast-Thinkers Game were kept, and some 'chance' cards were carried over from the PGCA Fast-Thinkers game. When arriving at a 'chance' block on the physical game board, the team must draw a 'chance' card (indicating to the playing team to either move 1 or 2 blocks forward/back, get an extra play turn, etc.). The 'chance' cards enhance the game's enjoyment and add more fun to the game (Koekemoer et al. 2023).

The PGCA Fast-Thinkers Game included a time limit of 30 s to improve time management, keep the game 'alive', and ensure a quick turnaround between the teams to keep everyone actively involved (Koekemoer et al. 2023). The time limit was adapted to 40 s for the Fast-Thinkers Game to give the Grade 12 learners more time than the time granted to the post-graduate students.

Development phase: A brief description of the game

In the adapted board game, one player describes Accounting terms or reads a mathematical word problem to their teammates, who must respond within 40 s, like the original *30 Seconds*® game. The rules of the Fast-Thinkers Game require that, depending on where the team is on board, the Accounting terms must be described, the mathematical word problem should be solved within the allocated time, or the instructions on the chance card should be followed.

At the start of the game – and whenever a team lands on an Accounting block – player draws an Accounting card and has 40 s to describe five terms without previewing the card. If the team lands on a mathematical block, the player reads a mathematical problem aloud for the team to solve within the same time limit. Each Accounting concept or term correctly identified within a turn of 40 s will allow the team to move one block forward until the end of the board is reached. Each mathematical problem solved allows the team to move two blocks forward until the end of the board is reached. The opposing team acts as the referee to ensure that the correct Accounting terms or concepts, or the correct mathematical problem, are described and other rules are followed.

If the team lands on a chance block (after completing their turn), the team will need to immediately pick up a chance card and do what the card instructs. The team that reaches the end of the board first or advances the furthest on board (by correctly identifying the most Accounting terms or concepts their teammates described, solving the most mathematical problems, and being the luckiest with the chance cards) wins.

Testing phase

After the development phase, the prototype game entered the testing phase of the DSR process. As recommended by Tang and Hanneghan (2014), playtesting was conducted to refine the game before final release. Two teams of first-year university Accounting learners were selected for testing the prototype game due to their similarity to the target audience. This group of learners has been used because they closely resemble the Grade 12 learners (they were Grade 12 learners a few months earlier) and come from a similar schooling background.

The researchers inquired from the testing groups whether 40s was a sufficient time limit per round, and the consensus was to keep to the 40s. Even though the teams advanced on average about two blocks during a turn, the first-year university Accounting learners felt that the 40s forced them to read and explain quickly, and it kept the game alive (i.e. the turnaround between teams is quick, and it kept everyone engaged). Therefore, the time limit per round was kept at 40s. During the testing phase, the number of blocks on the board was deemed appropriate. Furthermore, no changes were deemed necessary for the actual Accounting, Mathematics, or chance cards.

Post-testing design changes

Several adjustments were made to the game following the testing phase to enhance usability and fairness:

- Pen and paper were introduced to assist players, as many first-year Accounting students found it difficult to solve mathematical word problems without being able to write down figures.
- Rules were changed to allow players to re-read the mathematical problem while the timer runs because only hearing it once was insufficient for full comprehension.
- A new option was added for teams stuck on a mathematics block for two rounds – they may now draw a 'chance', 'Mathematics', or 'Accounting' card, after repeated stagnation led to frustration.
- An engagement feature was added: if the playing team fails to answer the problem on the Mathematics card, the opposing team can move one space (not two) for answering correctly, encouraging continuous participation.
- Player rotation rules were clarified to require strict clockwise turns without swaps, after one team tried to rearrange stronger players for an unfair advantage.

After the finalisation of the test phase, the intervention game comprised a set of rules, a game board, 100 cards (an Accounting pack of 55 cards, each with five words, a Mathematics pack of 25 cards, and 20 chance cards), a placeholder per team playing, one die, a pen and a piece of paper for each team member (see Figure 2).

Implementation phase

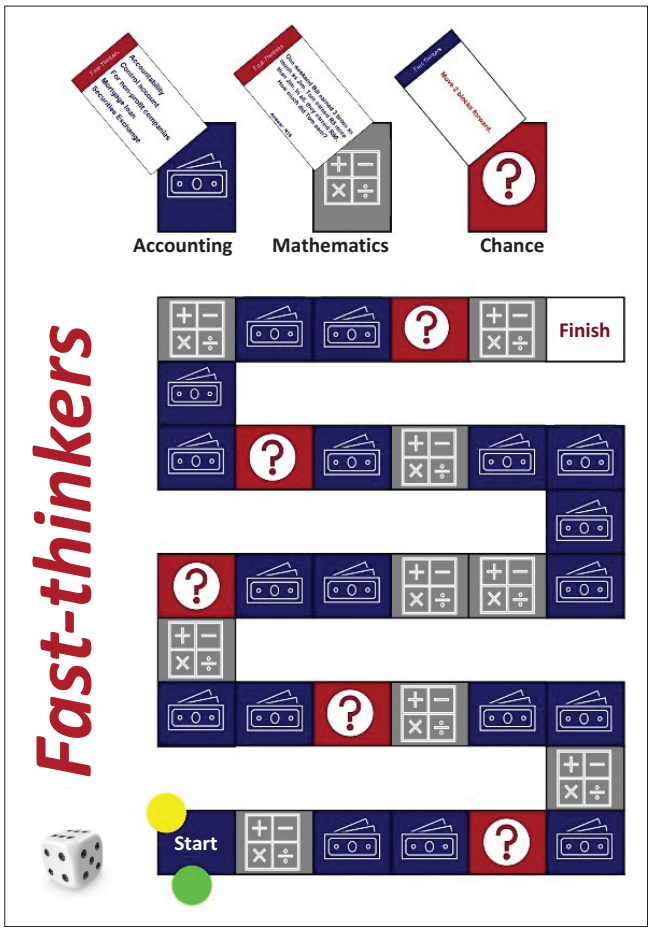
The Fast-Thinkers Game was played by Grade 12 learners at the Free State Finance and Accounting Sector Education and Training (FASSET) and SAICA Development Camp in July 2024, as described in the methodology section.

Evaluation phase

Questionnaires were used to answer the second research question, namely, the learners' perceptions about their skills development after playing the Fast-Thinkers Game. The results of the questionnaires, outlining the perceptions of the learners on which skills are being developed by playing the game (participating in the interdisciplinary intervention) are discussed in the next section.

Data collection

The research design incorporated both quantitative and qualitative data collection (Creswell & Plano Clark 2011). Questionnaires were used as data collection instruments after the completion of the game to fulfil the 'evaluation phase' of the DSR process indicated in the preceding subsection. The questionnaire consisted of both open-ended and closed-ended questions, whereby both qualitative and quantitative information were collected. The quantitative data obtained from the questionnaires were analysed to determine descriptive statistics, namely frequencies and



Note: This Figure represents the picture of the game designed. Used with permission, no unauthorised duplication allowed.

FIGURE 2: The Fast-Thinkers Game.

percentages for categorical data, as well as means and standard deviations or medians and percentiles for continuous data. Qualitative data were analysed using content analysis. This was described by Nieuwenhuis (2007) as an inductive and iterative process and allowed for multiple categories and subcategories or themes to develop as the researchers immersed themselves in the data, looking for similarities and differences, as well as issues that repeated.

The questions were based on the previous related research of the PGCA Fast-Thinkers game (on which the development of the new game was based) (Koekemoer et al. 2023), which identified that students perceived that the games positively assisted them in developing the following skills: communication skills, integration of subject 'languages', time management, short-term memory skills, comprehension of subject terminology and English language skills. For this study, the 'integration of subject languages' was replaced by the mathematical skills (see 5.1), as the various post-graduate subject areas were replaced by mathematical problems to be solved during the game. Furthermore, their research also mentioned reading skills that could be developed through GBL, and this aspect was included in the questionnaire. The related research also identified enjoyment, teamwork and engagement as educational benefits from the game. These aspects were also included in the questionnaires.

The Likert scale was used in the questionnaire as it is viewed as one of the most widely used scaling methods (Taherdoost 2019). The Likert scale measures are commonly used in assessing learners' perceptions (Tastle, Russell & Wierman 2005). A five-point Likert scale (1 = strongly disagree to 5 = strongly agree) was used to assess learner perceptions, consistent with established practice (see Chyung et al. 2017; Dermo 2009; Diemer, Fernandez & Streepey 2012; Ginns, Prosser & Barrie 2007; Koekemoer et al. 2023; Mellor & Moore 2014).

The intervention developed through this study was implemented and data were collected during the FASSET and SAICA Development Camp for Grade 12 learners hosted at a particular South African university. At this camp, academically talented Grade 12 learners from Quintile 1 to Quintile 3 schools were offered additional academic support in subjects, such as Mathematics, Physical Science and Accounting. In addition to the academic support provided, the camp offered life/soft skills training. Therefore, the camp was an ideal location to test this learning intervention, focusing on both technical and soft skills.

Sampling

Purposive sampling was used as the participants were the Grade 12 learners who were invited to attend the camp. The sample was 187 (learners who participated by playing the game and completed a questionnaire). Invalid responses were removed from the sample and only 176 valid responses are reported in this study. In the preceding section, it was mentioned that the camp offered additional academic support in Mathematics, Physical Science and Accounting. All the learners at the camp had Mathematics as a subject, but not Accounting, and learners were asked to indicate their highest level of Accounting or Economic and Management Sciences (EMS) as a school subject. Learners who did not have Accounting as a Grade 12 subject may have experienced the Accounting component of the game less positively.

The game requires teams to explain accounting terminology and to read and solve mathematical word problems. This requires communication in English. Hence, the learners were asked to indicate their home language.

However, a breakdown of the results (in the section below) between learners having Accounting as a Grade 12 subject and those who don't could be a possible future research area. Similarly, a breakdown of the results based on home language could also be an area for future research. Accordingly, the demographic information in Table 1 is given as background information only. The purpose of the article was not to conclude correlations between the various categories of learners (based on gender, having Accounting/EMS as a subject, home language, etc.) and their perceptions. Detailed demographic information was therefore not gathered through the questionnaire, which also ensured the anonymity of learners.

TABLE 1: Demographic information of the participants (*N* = 176).

The highest grade of Economic and Management Science (EMS) or Accounting learners have/had at school:	Number of participants	Percentage of participants
Grade 9	67	38
Grade 10	2	1
Grade 11	14	8
Grade 12	93	53
Total	**176**	**100**
Home language of the learners:		
isiXhosa	8	4
isiZulu	7	4
Sesotho	139	79
Setswana	12	7
siSwati	0	0
Tshivenda	0	0
Xitsonga	0	0
Sepedi	1	1
isiNdebele	0	0
Afrikaans	0	0
English	9	5
Total	**176**	**100**

The researchers provided the organisers of the Development Camp with the relevant information about the game. Interns (trained by the researchers) managed the learning intervention (game) and distributed the questionnaires afterwards. Although the participants were not offered payments, small inducements in the form of chocolates, sweets, etc., were offered to encourage their involvement in the project and as prizes for the winners of the various games played in teams. These incentives were not of such a significant nature that they were able to influence the outcome of the study.

Data analysis

The response rate was roughly 88% (176 of the roughly 200 learners in the group participated in the game, responded by completing the questionnaire and provided valid responses). The quantitative data from the questionnaires were analysed using descriptive statistics (IBM SPSS 29). Content analysis, which is a process that allows for multiple themes to develop as the researchers engage with the data, was used to analyse qualitative data. An open coding strategy was employed, whereby the data were examined line-by-line to allow themes to develop naturally without pre-defined codes. The researchers derived qualitative themes based on similarities, differences, and repetition (Nieuwenhuis 2007).

Ethical considerations

Ethical clearance was obtained from the particular university's ethics committee (HSD2024/1492) to distribute the questionnaires to the Grade 12 learners (participants). The organisers of the camp, SAICA, also granted permission for the game to be played and to use the collected data for research purposes. Parents of the participants (who were not 18 years old at that time) and the participants were requested to provide written consent to the organisers to attend the camp, and also before participating in the questionnaire. If a parent did not give consent, the learner(s) were still able to play the game, but did not complete the questionnaire. Furthermore, the learners were instructed only to complete the electronic questionnaire if their parents/themselves gave consent to participate in the research. The purpose of obtaining the data and the specific data utilised was explained to the parents and learners before the camp, and before the questionnaire was administered to them. The confidentiality of information obtained and shared was maintained; the identity of participants remains anonymous and will not be made public. The questionnaire did not contain any sensitive questions, and it was merely the perceptions of the learners that were asked in the questionnaires.

The preceding sections explained the application of the DSR process to address the first research question mentioned above. In the next section, the designed board game is evaluated by the Grade 12 learners who attended the Development Camp.

Results

This section provides an overview of the results of the questionnaires detailing the perceptions of the learners who played the game as an interdisciplinary learning intervention. Questionnaires were used to determine learners' perceptions of the Fast-Thinkers Game.

The tables summarise the responses from the participants. It indicates how strongly participants felt that the Fast-Thinkers Game addressed the skills being development and the benefits of the game. The Tables 2–5 indicate the number of participants for each of the categories of the Likert scale used. The percentage of participants per category is indicated in brackets. Furthermore, both positive responses (i.e. 'strongly agree' and 'agree') and both negative responses (i.e. 'disagree' and 'strongly disagree') were combined and indicated beneath the individual responses per category. The ranking of the results discussed below was determined by calculating the mean for each of the skills or benefits as indicated in the tables. The results are ranked in the tables in the sequence from the most positive to the least positive responses, as indicated in the 'rank' column.

Development of skills

The second research question relates to the Grade 12 school learners' perceptions about their skills developed in accountancy and mathematics education, and other pervasive skills, after playing the Fast-Thinkers Game. The results indicate that they perceived all the identified skills to be developed by the game, and that time management skills were the most developed pervasive skill. This was followed by the short-term memory and reading skills. Interestingly, the learners ranked the development of subject-related skills for Accounting and Mathematics only as fourth and fifth (after other pervasive skills).

On average, 79.4% of the participants either strongly agreed or agreed that their skills were developed, which indicates that learners perceived the Fast-Thinkers Game as positively developing their skills and, thus, achieved the objectives of the game. On average, only 7.2% of the

participants felt that the game did not improve their skills development areas (by indicating that they strongly disagreed or disagreed).

Benefits of the game

Similar to the research by Koekemoer et al. (2023), the researchers wanted to determine the learners' perception of the benefits of the game. From Table 2, it is clear that the learners felt more positively about the benefits of the games compared to the skills being developed. The combined positive percentages for 'strongly agree' and 'agree' are generally higher than the percentages for the skills (except for time management in Table 3). The responses indicate that, on average, almost 85% of the learners agreed that enjoyment, teamwork and engagement are indeed benefits of the game.

Perceived level of difficulty of the accounting and mathematical components

In the methodology section, it was indicated that not all learners had Accounting in Grade 12, but that a breakdown of the results between learners having Accounting as a Grade 12 subject and those who didn't be possible future research. In evaluating the game, the researchers still wanted to identify how difficult the participants perceive the accounting and mathematical components of the game. Although all the participants had Mathematics as a subject in Grade 12, Table 4 indicates that the mathematical word problems were perceived as more difficult than the Accounting terminology. This is somewhat surprising as only 53% (Table 1) of the participants had Accounting as a Grade 12 subject, and the word problems were obtained from numerous Mathematics papers set in the past by the DBE from Grade 9 to 12. Still, the highest frequency for the perceived difficulty level of the mathematical word problems was for the 'neutral' category (40.9%), with the second highest frequency for 'difficult' (24.4%). The highest frequency for the perceived difficulty level of the Accounting terminology was also for the 'neutral' category (26.7%), with the second highest frequency for 'easy' (25.0%). One can deduce that even learners who did not have Accounting as a Grade 12 subject were still generally able to understand and describe the Accounting terminology on the game cards.

General evaluation of the game as a learning intervention

In the last closed-ended questions, the participants were asked for their perception on whether the Fast-Thinkers Game could generally be used as a learning intervention to develop pervasive skills, as indicated earlier, positively. Also, the participants were asked whether they think that games and fun elements can generally be used in education, and whether they were more engaged during the game compared to a formal learning activity (e.g. typical class or lecture). The responses are summarised in Table 5. The participants were overwhelmingly positive about the

TABLE 2: Skills developed through the Fast-Thinkers Game for Grade 12 learners (N = 176).

Skill	Strongly agree		Agree		Total		Neither Agree or disagree		Disagree		Strongly disagree		Total		SD	Mean	Rank
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%			
Time management	102	58.0	47	26.7	149	84.7	17	9.7	8	4.5	2	1.1	10	5.6	0.915	4.36	1
Short-term memory skills	92	52.3	54	30.7	146	82.9	20	11.4	8	4.5	2	1.1	10	5.6	0.919	4.28	2
Reading skills	81	46.0	66	37.5	147	83.5	18	10.2	8	4.6	3	1.7	11	6.3	0.925	4.22	3
Comprehension of accounting subject terminology	90	51.1	47	26.7	137	77.8	23	13.1	8	4.6	8	4.5	16	9.1	1.103	4.15	4
Mathematical skills	84	47.7	51	29.0	135	76.7	29	16.5	6	3.4	6	3.4	12	6.8	1.035	4.14	5
Verbal communication skills	84	47.7	52	29.6	136	77.3	24	13.6	9	5.1	7	4.0	16	9.1	1.081	4.12	6
English language skills	68	38.6	66	37.5	134	76.1	33	18.8	7	4.0	2	1.1	9	5.1	0.913	4.09	7
Verbal communication of accounting terminology	79	44.9	55	31.3	134	76.2	24	13.6	9	5.1	9	5.1	18	10.2	1.120	4.06	8

SD, standard deviation.

TABLE 3: Benefits developed through the Fast-Thinkers Game (N = 176).

Benefit	Strongly agree		Agree		Total		Neither Agree or disagree		Disagree		Strongly disagree		Total		SD	Mean	Rank
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%			
Enjoyment	117	66.5	35	19.9	152	86.4	6	3.4	10	5.7	8	4.5	18	10.2	1.094	4.38	1
Teamwork	108	61.4	40	22.7	148	84.1	17	9.7	5	2.8	6	3.4	11	6.2	1.004	4.36	2
Engagement	99	56.2	48	27.3	147	83.5	15	8.5	7	4.0	7	4.0	14	8.0	1.046	4.28	3

SD, standard deviation.

TABLE 4: Perceived difficulty (N = 176).

Perceived difficulty	Very easy		Easy		Total		Neutral		Difficult		Very difficult		Total		SD	Mean	Rank
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%			
Mathematical problems	18	10.2	21	11.9	39	22.1	72	40.9	43	24.4	22	12.5	65	36.9	1.118	2.83	2
Accounting terminology	38	21.6	44	25.0	82	46.6	47	26.7	19	10.8	28	15.9	47	26.7	1.343	3.26	1

SD, standard deviation.

TABLE 5: The Fast-Thinkers Game as a learning intervention to develop skills (N = 176).

Evaluation of the game	Strongly agree		Agree		Total		Neither Agree or disagree		Disagree		Strongly disagree		Total		SD	Mean
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%		
The game as a learning intervention to develop skills	127	72.2	37	21.0	164	93.2	6	3.4	3	1.7	3	1.7	6	3.4	0.786	4.60
Using games and fun in Accounting and mathematics education	120	68.2	39	22.2	159	90.4	9	5.1	3	1.7	5	2.8	8	4.5	0.894	4.51
Were you more engaged while playing the games than you usually are during a formal learning activity (e.g. a class)	99	56.2	48	27.3	147	83.5	15	8.5	7	4.0	7	4.0	14	8.0	1.046	4.28

SD, standard deviation.

game, with 93.2% agreeing that the game can be used as a learning intervention to develop pervasive skills positively. More than 90% (68.2% for 'strongly agree' and 22.2% for 'agree') of the participants also agreed that games and fun elements can generally be used in education, while 83.5% agreed that they were more engaged during the game than in a class.

The second section of the questionnaire consisted of open-ended questions (as part of the evaluation phase of the DSR process). Most participants answered the open-ended questions, thereby providing in-depth insights and a comprehensive understanding of the learners' perceptions. It is submitted that focus group interviews were unnecessary, given the richness of the information gathered from the open-ended questions in the questionnaire.

How learners experienced the game

In the first open-ended question, learners were asked to comment on their experience playing the Fast-Thinkers Game. Most responded highly positively, showing that they perceived the game as beneficial, a good experience, and they enjoyed playing the game while improving their pervasive skills. A few of the more detailed responses were as follows:

- 'Fast-Thinkers is a game that puts you on the edge of your seat. It is fun and it takes out your competitive side, which is amazing'.
- 'I experienced fast thinking'.
- 'Fun, because I love problem-solving combined with fast thinking, Accounting questions were so easy and fun for me, and it was my first time doing Accounting since grade 9'.
- 'It was very fun and hard at the same time. It has educated me so much'.

On the downside, some participants indicated that the game was challenging (it seems that they did not fully understand the rules initially). Also, some participants indicated that their experience was not good, as their teams did not work well together or argued with the opposing team.

Would learners recommend the game?

Most of the participants reacted positively to this open-ended question and highlighted that the game helps to improve accounting and mathematical skills, and various other pervasive skills. The following responses summarised the general feeling:

- 'Definitely, because it makes learning fun'.
- 'Yeah, because it enables one to explain their thoughts and test their knowledge and understanding of the contents'.
- 'Yes, because if you can explain the terminology, you can actually understand the whole subject'.
- 'Yes, because it helps you to improve your Mathematics solving skills'.
- 'Yes, because it helps you to think critically about certain situations or problems to solve them'.
- 'Yes, it requires one to think out of the box'.

Despite the overwhelming positive feedback, only a few participants indicated that they would not recommend the game as they are not pursuing Accounting, and the game caused disagreements between the teams.

Other pervasive skills promoted by the game

Lastly, the participants were asked what other pervasive skills they perceived the Fast-Thinkers Game promoted. Most of the participants indicated various skills, such as listening, cognitive, collaboration, and leadership skills. These skills may be encompassed in the skills already identified, such as teamwork and communication skills. The only other skill mentioned by many participants was critical thinking. The evaluation of how the game can improve learners' critical thinking skills may be an area for future research.

Limitations

This study did not explore correlations between learners' developed skills and demographics, such as second-language speakers, and learners having Accounting as a Grade 12 subject or not. This may limit the results of the article. The generalisability of the results may also be limited, given the fact that the questionnaire was only administered to specific learners who attended one FASSET and SAICA Development Camp in South Africa. The development of the accounting, mathematical and other pervasive skills was further measured only using student perceptions, which can be biased and limit objectivity.

Conclusion

The main purpose of this study was to adapt a previously developed board game as an interdisciplinary learning intervention to positively enhance Grade 12 learners'

comprehension of Accounting concepts, mathematical problem-solving, communication and other pervasive skills, and to report on the learners' perceptions thereof. The various phases of the DSR process (Pelser-Carstens 2022) were followed to adapt the game to be relevant and appropriate to Grade 12 learners. The main adjustments made were to have one set of game cards for Accounting (not for the four subdivisions of accountancy) and to add mathematical problems to be solved. The very positive responses suggest that educational games, specifically the Fast-Thinkers Game, could be used as an interdisciplinary tool to enhance Grade 12 learners' comprehension of Accounting concepts, mathematical problem-solving, communication and other pervasive skills. The results of the study confirmed the various skills that could be developed through playing the Fast-Thinkers Games, and it confirmed the benefits of GBL in education, as suggested by the literature and a previous related study (Koekemoer et al. 2023).

Looking forward, exploring correlations between the learners' demographic information and their perceptions based on their gamification experience could be an area for future research. Furthermore, an in-depth analysis of the results from this study (Grade 12 learners) compared to the results of the previous related study (Koekemoer et al. 2023) (post-graduate students) could also be an area for future research.

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CRediT authorship contribution

Celesté Brittz: Conceptualisation, Project administration, Writing – review & editing. Hendri Theron: Conceptualisation, Project administration, Writing – original draft, Writing – review & editing. Jacobus Rossouw: Conceptualisation, Methodology, Project administration, Writing – original draft, Writing – review & editing. Aletta D. Koekemoer: Conceptualisation, Formal analysis, Methodology, Writing – review & editing. Elmarie Goodchild: Conceptualisation, Writing – review & editing. Kobus Swanepoel: Conceptualisation, Writing – review & editing. All authors reviewed the article, contributed to the discussion of results, approved the final version for submission and publication, and take responsibility for the integrity of its findings.

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Data availability

The data that support the findings of this study are available from the corresponding author, Hendri Theron upon reasonable request.

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