RESEARCH ARTICLE:

The Inclusion of Design Thinking as a Tool for Entrepreneurship at the Durban University of Technology

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Abstract

The volatile nature of the entrepreneurship environment requires specific characteristics from individuals entering the field. These traits can be developed through entrepreneurial learning, utilising a method- and design-based approach known as design thinking (DT). Design Thinking prioritises the entrepreneurial process, particularly the mindset and skills of student entrepreneurs. It also encourages student-centred learning by ensuring that the acquired skills are applicable to real-life situations. The study evaluated the inclusion of DT as an entrepreneurship and business development tool at the Durban University of Technology. Entrepreneurial learning through a design-based and method approach was conceptualised. A quantitative research approach was used, focussed on students who have either enrolled in entrepreneurship modules that follow the DT approach or in courses that do not follow the DT approach, for comparative purposes. The collection of data was done using a semi-structured questionnaire. Thereafter, SPSS version 24 was used to analyse the collected data. The study results showed a lack of awareness concerning DT, and that most participants have not enrolled in DT boot camps or workshops. This lack is evident in the limited number of ventures undertaken by participants. In conclusion, an intervention is recommended which will allow the incorporation of DT into the Higher Education Institution curriculum to foster innovation and the execution of novel ideas.

Keywords: *entrepreneurship; design thinking; ventures; innovation*

Introduction

Entrepreneurship is defined as the pursuit of business ventures where individuals take risks and manage trade to create new products or services (Hisrich *et al*., 2018). According to Ndlovu *et al*. (2023), successful entrepreneurs possess skills such as resilience, creativity, as well as adaptability, and they constantly search for opportunities to address problems and innovate. Entrepreneurship is therefore important in driving economic growth, job creation, and social change. In addition, Aldrich (2019) states that entrepreneurship also promotes social mobility and inclusivity by availing opportunities for persons from diverse cultures and backgrounds to start businesses. However, while entrepreneurship offers potential rewards, it also comes with challenges such as funding constraints and market competition. Entrepreneurship education has evolved, with a shift towards combining traditional and innovative teaching methods (Kuratko, 2005). However, there are gaps and limitations in entrepreneurship education in Africa, such as a lack of focus on developing an entrepreneurial mindset, and challenges in accessing education and resources. Despite these challenges, there is growing recognition in Africa of the importance of entrepreneurship education, and initiatives have been implemented to improve entrepreneurship education as well as foster an entrepreneurial ecosystem (Gamede and Uleanya, 2019; Ndlovu *et al*., 2023; Nkomo, 2015).

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Higher education institutions (HEIs) have the difficult task of developing their curricula considering the demands of labour markets in a world that is dynamic, increasingly technologically oriented, and presenting ill-defined difficulties (Griffin *et al.,* 2012). The World Economic Forum (2025) emphasizes problem-solving and creativity as two of the top five skills that employers will seek in the future, highlighting the need for these twenty-first-century skills alongside traditional knowledge (Binkley *et al.*, 2012). In South Africa, increasing unemployment rates and the lack of new business prospects require urgent attention. If left unaddressed, the country will face economic instability due to limited economic activities. This study addresses the lack of an entrepreneurial mindset and problem-solving skills among students, which hinder their ability to thrive in dynamic business environments. The research questions guiding this study are: How does Design Thinking (DT) influence students' entrepreneurial ambition and intention at DUT? What impact does DT have on students' entrepreneurial mindset at DUT? and What is the feasibility of incorporating DT as an entrepreneurial facilitation tool at DUT? The objectives of this study are to evaluate the influence of Design Thinking on students' entrepreneurial ambition and mindset at DUT, assess the feasibility and effectiveness of integrating Design Thinking into the entrepreneurial curriculum at DUT, and explore the potential benefits and challenges of including Design Thinking as a tool for fostering entrepreneurial skills at DUT.

Therefore, there is a need for interventions in entrepreneurial education, to introduce and execute Design Thinking (DT), for entrepreneurs to have the additional skills set necessary to succeed in a variety of environments. Since Universities of Technology (UoT), like the Durban University of Technology (DUT), already offer a variety of programmes that encourage entrepreneurship, the UoT will be a key force behind the integration of DT into the curriculum with concrete measurements. To incorporate DT into the entrepreneurial curricula easily, Sarooghi *et al*. (2019) created an opportunity design framework in which the idea of DT is linked to an alignment-based paradigm. It is imperative to integrate entrepreneurial processes into the existing curricula in a way that enables students to develop new skills and competencies in a secure, user-friendly, learning environment that minimizes the risk of failure. DT has gained attention in entrepreneurship education as it fosters innovation and problem-solving skills among aspiring entrepreneurs. Kimbell (2011) argues that DT allows students to engage with real-world users and customers to obtain valuable feedback, promoting practical, hands-on learning. Dam and Siang (2021) posit that DT helps students challenge assumptions and address real-world problems through innovative solutions that can be prototyped and tested. Integrating DT principles into entrepreneurship education provides students with a learning experience that prepares them for the dynamic nature of the business world (Auernhammer and Roth 2021; Micheli *et al*., 2019; Tham, 2020).

This study conceptualises learning entrepreneurship through a design-based approach, aiming to evaluate the inclusion of DT as an entrepreneurship facilitation method in the Faculty of Management Science at DUT under the Department of Entrepreneurial Studies.

Literature Review

Entrepreneurship is a vital force for driving economic and social progress in society. It is of paramount importance for economic growth, job creation, wealth generation, technological and social advancement, as well as overall societal progress. Baker and Welter (2020) state that entrepreneurship serves as a catalyst for innovation, drives economic development and fosters resilience and adaptability in the face of changing environments. It encourages competition, fosters creativity and problem-solving, and promotes the efficient allocation of resources. Furthermore, entrepreneurship also promotes social mobility and inclusivity by availing opportunities for individuals from varied backgrounds to establish businesses and achieve economic independence. Additionally, entrepreneurs play a crucial part in driving economic sustainability and addressing pressing worldwide challenges, such as climate change and inequality (Akhmetshin *et al*., 2019). DT has emerged as a significant concept within the broader field of design theory. Design theory encompasses various perspectives, methodologies, and frameworks that aim to understand the principles and processes underlying the design practice. DT can be seen as a specific approach within the larger framework of design theory since it incorporates elements from various design theories and disciplines, including but not limited to industrial design, architecture, and human-computer interaction. It draws upon theories of problem-solving, creativity, and user-centred design to provide a structured approach to tackling complex problems and driving innovation (Tham, 2022). Most importantly, DT has contributed to the evolution and diversification of design theory by offering a distinct problem-solving methodology emphasising the importance of empathy, collaboration, and iterative processes in design practice (Auernhammer and Roth, 2021; Micheli *et al*.,

2019; Tham, 2022). This is how DT became a mainstream approach in various sectors and has been embraced for its potential to drive growth, innovation, and social change.

The application of DT in entrepreneurship education has shown great potential in fostering innovation, critical thinking, and creativity among aspiring entrepreneurs. DT encourages students to approach problems from multiple perspectives, promoting a more empathetic and adaptable mindset. It has been found to significantly enhance entrepreneurial skills by providing a structured yet flexible approach to idea generation, prototyping, and market testing (Shé *et al*., 2022). In fact, the application of DT in entrepreneurship education allows students to experience real-world problems and engage with customers to receive feedback, providing them with valuable insights that traditional methods often lack (Kimbell, 2011). However, there is a growing need for more research into the best ways to incorporate DT processes and tools into entrepreneurship education programs effectively, particularly in terms of adapting them to different educational contexts (Daniel, 2016; von Thienen *et al*., 2023). In South Africa, initiatives have been introduced to engage students in entrepreneurship education, such as the pilot core syllabus for entrepreneurship and economic education in schools (Forcher-Mayr and Mahlknecht, 2020). However, entrepreneurship education in South African higher education institutions is still evolving, with a primary reliance on traditional teaching methods that may not fully address the dynamic needs of today's entrepreneurial landscape. The integration of interactive, experiential methods, like simulation and Design Thinking, is critical to developing students' analytical and decision-making skills (Gamede, 2019; Ndlovu *et al*., 2023; Nkomo, 2015). South African institutions of higher learning are recognizing the importance of entrepreneurship education, but there is a growing need for more innovative and practical approaches that can better equip students for real-world challenges.

DT offers a promising approach to fill this gap by providing students with practical, hands-on learning experiences that focus on solving problems through purposeful innovation. By adopting DT principles in entrepreneurship education, institutions can equip students with the skills needed to tackle real-world business challenges, think creatively, and adapt to rapidly changing market conditions.

Methodology

This study employed a mixed-methods research design, combining both quantitative and qualitative approaches to gain a comprehensive understanding of the impact of design thinking (DT) on entrepreneurship education. The primary approach was quantitative, as this allowed for comparison of numerical data and facilitated statistical inferences about the differences and similarities between two groups. However, qualitative data were also collected through open-ended questions, which provided deeper insights into participants' experiences and perceptions, enriching the overall findings. The target population included all students registered for entrepreneurial modules in the Faculty of Management Sciences: Entrepreneurial Studies Department, consisting of two cohorts — a bootcamp group with approximately 900 students and a general lecture group with 91 students. The study sample comprised 204 students out of 278 who consented to participate, resulting in a 73.4% response rate. Only students attending Entrepreneurial Edge 101 and Introduction to Technopreneurship 101 modules were invited to participate. These modules were selected because they are served by the department that curated the entrepreneurship curriculum. The core content of both modules was the same, except that one cohort included Design Thinking (DT) in its syllabus, while the other did not.

A gatekeeper's letter and ethical approval from the Durban University of Technology Ethics Committee were obtained to conduct the study. The first page of the form required the participants to state if they fully understood the brief of the study, the purpose and what the study results will be used for. Data were collected exclusively from participants who provided consent. A total of 204 out of 278 students gave consent to participate in this study across five faculties at the university, suggesting a 73.4% response rate. The questionnaires were sent to students who were attending Entrepreneurial Edge 101 and Introduction to Technopreneurship 101 modules serviced by the Department of Entrepreneurial Studies and Management. This population was selected on the basis that they are being serviced by the department that curated the curriculum, and the content was almost the same with the exception that one cohort did not have the design thinking included in their syllabus. A total of 278 questionnaires were sent via student emails to students registered for the selected entrepreneurship modules. Of this number, only 204 questionnaires were returned, which yielded a 73.4% response rate. The response rate was calculated as follows

The data was collected in September 2023 via Google Forms. Student emails were used to distribute the questionnaires using their class registers and lecturers were requested to make students aware of the

questionnaires in their emails and the researcher was granted 5 minutes slot to urge the students to respond. The questionnaire was divided into four parts namely, Part One provided the respondent the information about the research and the respondent was asked if they consented to participate in the study. Part Two (Section 1) was Demographics, Part Three (Section Two) was the Design Thinking and Entrepreneurship and Part Four (Section Three) was Open-Ended questions. Section 1 of the questionnaire was about the demographics of the students. This section was requesting age, gender, faculty, year of study, their exposure to entrepreneurship and the format of their entrepreneurship class. This was done to determine if there is a correlation between the demographics and the type of format for teaching entrepreneurship. Section 2 of the questionnaire was about Design Thinking and Entrepreneurship. This section examined the level of exposure the students had to design thinking and entrepreneurship and evaluated their level of intention to become entrepreneurs whilst still in university and post-university. Section 3 of the questionnaire was open-ended questions. This was to evaluate how the respondents found the curriculum of entrepreneurship, their application of DT within their lifestyle and the development they believe can be made in the entrepreneurship curriculum.

In this research, the quantitative data was analysed using SPSS version 24 to ensure rigor and reliability of the study. This statistical software was used to analyse data, perform descriptive and inferential analyses including correlation analysis. This integrated approach allowed the study to not only compare statistical trends across groups but also explore participants' nuanced views, thereby enriching the overall interpretation of the impact of design thinking on entrepreneurship education.

Findings

The quantitative data were analysed using SPSS version 24. The demographic characteristics of the respondents indicate a predominance of younger students, with the majority falling within the 20–22 age group (Fig. 1). The gender distribution shows a higher proportion of female respondents, while the faculty breakdown highlights that most participants are from the Applied Sciences faculty, as shown in Figures 2 and 3. Additionally, the level of study (Fig. 4) reveals a concentration of respondents in their first and second years, suggesting a relatively young cohort in terms of academic progression. These results provide valuable context for understanding the sample population and lay the groundwork for further analysis of the study's key findings related to Design Thinking (DT) and entrepreneurship education.

Figure 1 depicts the age distribution of the respondents. The data shows that the majority falls into the 20-22 age group (55.4%), followed by 17-19 (28.9%), 23-25 (10.3%), and 26+ (5.4%).

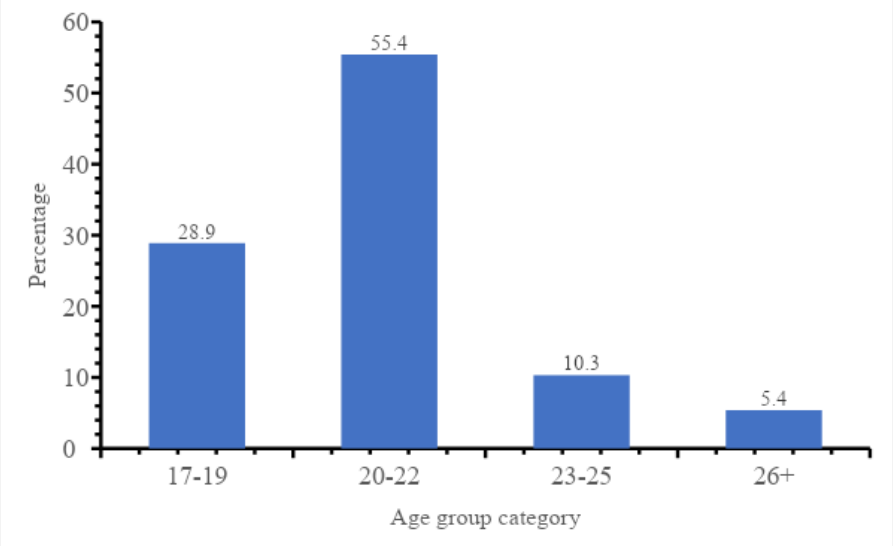

Figure 1: Age distribution of the respondents

Figure 2 shows the gender distribution of the respondents, with 38.1% identifying as male and 61.9% identifying as female among the valid responses.

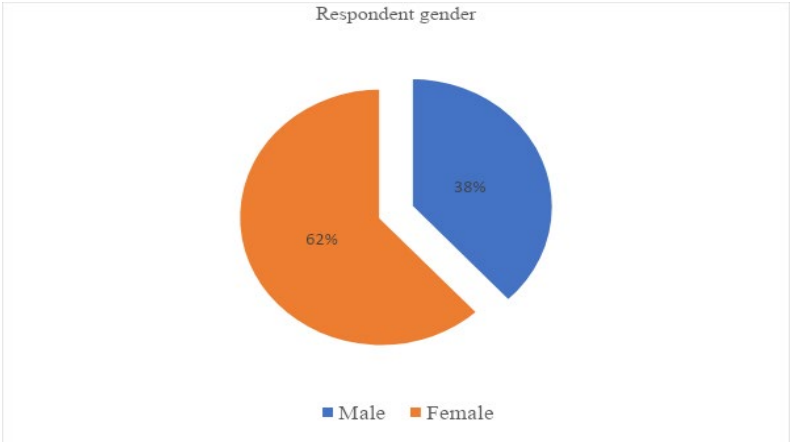

Figure 2: Gender of respondents

Figure 3 depicts the distribution of respondents across different faculties or fields of study, with the majority (85.3%) from the Applied Sciences faculty, followed by Arts and Design (8.3%), Accounting and Informatics (3.4%), Health Sciences (2.0%), and Management Sciences (1.0%).

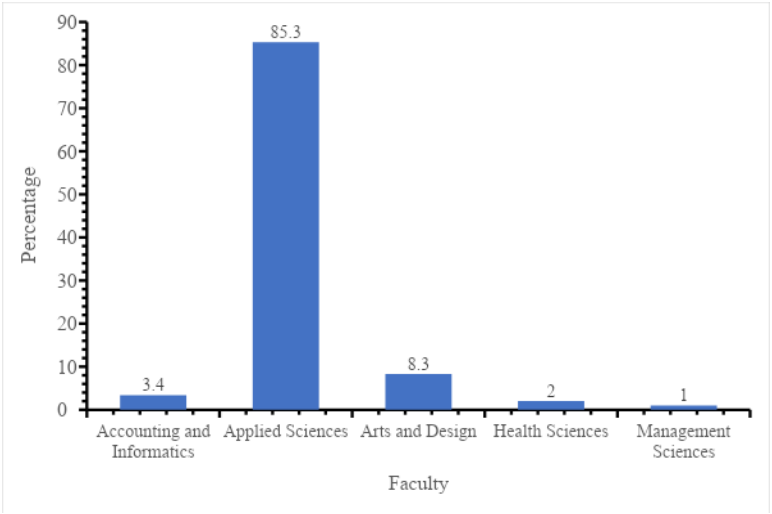

Figure 3: Faculty of respondents

Figure 4 provides information about the distribution of respondents across different years of study. The majority (48.5%) were in their 1st year, followed by the 2nd year (43.1%), with smaller numbers in the 3rd year (4.4%), 4th year (2.9%), and 5th year (0.5%). There were also respondents who were DUT alumni (0.5%).

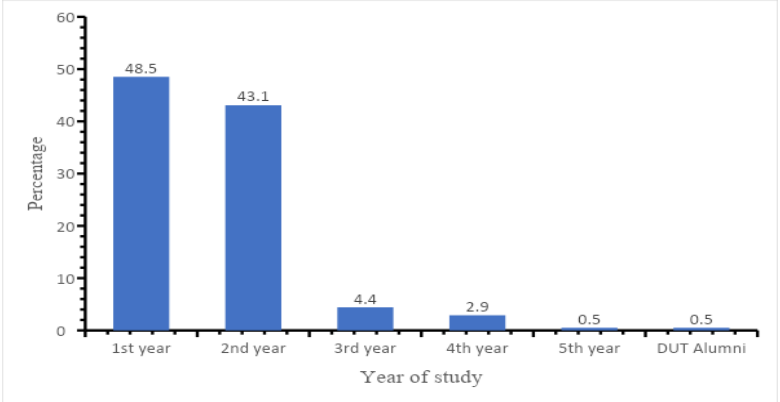

Figure 4: Respondents level of study

Table 1 reflects the responses of the respondents based on whether they have previously taken courses on entrepreneurship. The data shows that the majority of respondents (75.0%) have not previously taken courses on entrepreneurship, while a minority (25.0%) have taken such courses.

Table 1: Number of respondents who have previously taken course on entrepreneurship

		Frequency	Percentage
Have you previously taken any courses on entrepreneurship?	No	153	75.0%
	Yes	51	25.0%
	Total	204	100.0%

Most respondents (80.9%) have not started entrepreneurial ventures while at university, suggesting that entrepreneurial activity is still relatively limited among this group. However, among those who have ventured into entrepreneurship (19.1%) (Table 5 and 6), a large proportion (84.6%) indicated that Design Thinking (DT) played a role in sparking the idea for their ventures, highlighting the influence of creative problem-solving methodologies in entrepreneurship.

When evaluating the perceived value of Design Thinking in entrepreneurial ventures, respondents showed a generally positive attitude, with a mean value of 3.77, indicating that they view DT as moderately valuable in the entrepreneurial process. Additionally, there is a strong likelihood (mean of 3.71) that respondents would use DT in the future when starting new ventures. The significant differences in these perceptions emphasize the potential of DT as an important tool for future entrepreneurs.

The responses regarding experiences with DT revealed that many respondents either had no prior exposure to DT (36.3%) or had used it in educational assignments (23.5%) (Table 3), with a smaller percentage applying it directly in entrepreneurial ventures (6.4%). These findings underscore the potential for expanding the use of DT in both academic settings and practical entrepreneurial applications. Furthermore, personal aspirations and reflections shared by respondents highlight a growing interest in applying DT to solve societal problems through entrepreneurship, further reinforcing its relevance in fostering innovation and creativity

Table 2 reflects the number of respondents who did attend the bootcamp (3-5 days) or timetabled class (every week). The data shows that the majority of respondents (88.7%) attended timetabled classes on a regular basis, while a smaller portion (11.3%) attended a bootcamp that lasted 3-5 days.

Table 2: Number of respondents who attended bootcamp or timetabled class

		Frequency	Percentage
Did you attend the bootcamp (3-5 days) or Timetabled class (every week)	Bootcamp	23	11.3%
	Timetabled	181	88.7%
	Total	204	100.0%

Table 3 reflects the responses to the questions about DT. When asked if the respondents have heard of DT, the data revealed that the majority of respondents (75.5%) have heard of DT, while a smaller percentage (24.5%) have not. When asked if the respondents have participated in any DT workshops, the results suggest that a significant majority of respondents (73%) have not participated in DT workshops or courses, while a smaller percentage (27%) have engaged in such activities.

Table 3: Respondents' knowledge and participation in Design Thinking course or workshops

	No n (%)	Yes n (%)
Have you heard of Design Thinking?	50 (24.5%)	154 (75.5%)
Have you participated in any Design Thinking workshops or courses?	149 3%)	55 (27%)

Table 4 responds to questions about the level of confidence in generating and executing new ideas. The response categories are on a scale from 1 to 5, with 1 being the lowest level of confidence and 5 being the highest. One-sample t-test was performed to determine if there are significant differences in each of the response. In terms of the level of confidence about their ability to generate new ideas, 5.9% of respondents feel very unconfident (rated 1), 12.3% are somewhat unconfident (rated 2), 36.3% are neutral or moderately confident (rated 3), 27.5% are somewhat confident (rated 4), and 18.1% are very confident (rated 5). The average response score is 3.40, which indicates that, on average, respondents have a moderate level of confidence in their ability to generate new ideas. The p-value suggests that there is a significant difference in respondents' confidence levels regarding generating new ideas ($t(203)= 44,180$; $p<0.001$).

In terms of the respondent's confidence about their ability to execute on new ideas, 5.9% of respondents feel very unconfident (rated 1), 21.1% are somewhat unconfident (rated 2), 32.8% are neutral or moderately confident (rated

3), 24% are somewhat confident (rated 4), and 16.1% are very confident (rated 5). The average response score is 3.24, which indicates that, on average, respondents have a moderate level of confidence in their ability to execute on new ideas. The p-value measured suggests that there is a significant difference in respondents' confidence levels regarding executing new ideas (t (203) = 40,776; p<0.001).

In summary, the above results suggest that the surveyed individuals generally have moderate confidence in their ability to generate and execute new ideas. Overall, the respondents' confidence in executing on new ideas appears to be slightly lower on average (mean of 3.24) compared to their confidence in generating new ideas (mean of 3.40).

Confidence in entrepreneurial abilities

Table 4 responds to questions about the level of confidence in generating and executing new ideas. The response categories are on a scale from 1 to 5, with 1 being the lowest level of confidence and 5 being the highest. One-sample t-test was performed to determine if there are significant differences in each of the response. In terms of the level of confidence about their ability to generate new ideas, 5.9% of respondents feel very unconfident (rated 1), 12.3% are somewhat unconfident (rated 2), 36.3% are neutral or moderately confident (rated 3), 27.5% are somewhat confident (rated 4), and 18.1% are very confident (rated 5). The average response score is 3.40, which indicates that, on average, respondents have a moderate level of confidence in their ability to generate new ideas. The p-value suggests that there is a significant difference in respondents' confidence levels regarding generating new ideas (t(203)= 44,180; p<0.001). In terms of the respondent's confidence about their ability to execute on new ideas, 5.9% of respondents feel very unconfident (rated 1), 21.1% are somewhat unconfident (rated 2), 32.8% are neutral or moderately confident (rated 3), 24% are somewhat confident (rated 4), and 16.1% are very confident (rated 5). The average response score is 3.24, which indicates that, on average, respondents have a moderate level of confidence in their ability to execute on new ideas. The p-value measured suggests that there is a significant difference in respondents' confidence levels regarding executing new ideas (t (203) = 40,776; p<0.001).

Table 4: Respondents level of confidence in ability to generate and execute new ideas

Response	**Level of confidence on ability to generate and execute new ideas (n=204)**								
	1	**2**	**3**	**4**	**5**	**Mean(Std)**	**t**	**Df**	**P**
How confident do you feel about your ability to generate new ideas?	5.9%	12.3%	36.3%	27.5%	18.1%	3.40(1.098)	44.180	203	<,001
How confident do you feel about your ability to execute on new ideas?	5.9%	21.1%	32.8%	24%	16.2%	3.24(1.133)	40.776	203	<,001

Entrepreneurial activity

Table 5 reflects the response to the question seeking to know if the respondents have started any entrepreneurial ventures while at university. The table shows that the majority of respondents (80.9%) have not started any entrepreneurial ventures while in university, while a smaller percentage (19.1%) have engaged in entrepreneurial activities during their time in university. Among those who started entrepreneurial ventures while in university, the majority (84.6%) indicated that DT did help spark the idea for their ventures, while a smaller percentage (15.4%) stated that it did not play a role (Table 6).

Table 5: Respondents' response to starting entrepreneurial ventures while in university

		Frequency	**Percentage**
Have you started any entrepreneurial ventures while in university?	No	165	80.9%
	Yes	39	19.1%
	Total	204	100.0%

Table 6: Influence of Design Thinking on sparking idea for entrepreneurial ventures

		Frequency	**Percentage**
If yes, did Design Thinking help spark the idea for your entrepreneurial venture?	No	6	15.4%
	Yes	33	84.6%
	Total	39	100.0%

Perceptions of design thinking

The data in Table 7 show responses related to the perceived value and likelihood of using DT in the process of starting entrepreneurial ventures. The response categories were on a scale from 1 to 5, with 1 being the lowest perceived value and 5 being the highest. A one-sample t-test was performed to determine if there were significant differences in each of the responses. In terms of how valuable respondents believe DT is in the process of starting an entrepreneurial venture, 6.9% of respondents see DT as not valuable (rated 1), 5.9% as somewhat valuable (rated 2), 25.0% as moderately valuable (rated 3), 27.9% as valuable (rated 4), and 34.3% as highly valuable (rated 5). The mean score measured was 3.77, indicating that, on average, respondents perceive DT as having a moderately high value in the process of starting entrepreneurial ventures. The p-value is <0.001, suggesting that there is a significant difference in respondents' perceived value of DT in the context of starting entrepreneurial ventures.

In terms of how likely the respondents are to use DT in the future when starting an entrepreneurial venture, 6.9% of respondents see DT as not likely (rated 1), 9.3% as somewhat likely (rated 2), 23.5% as moderately likely (rated 3), 27.0% as likely (rated 4), and 33.3% as highly likely (rated 5). Respondents expressed a high likelihood (mean of 3.71) of using DT in the future when starting entrepreneurial ventures. The p-value of <0.001, suggests that there is a significant difference in respondents' perceived likelihood of using DT in the future when starting entrepreneurial ventures.

Table 7: Respondents' perception of Design Thinking as valuable in the process of starting entrepreneurial ventures and the high likelihood of using it in the future

Response	**Values and likelihood of using Design Thinking in entrepreneurial venture (n=204)**								
	1	2	3	4	5	Mean (Std)	T	Df	P
How valuable do you believe DT is in the process of starting an entrepreneurial venture?	6.9%	5.9%	25.0%	27.9%	34.3%	3.77(1.183)	45.506	203	<0,001
How likely are you to use DT in the future when starting an entrepreneurial venture?	6.9%	9.3%	23.5%	27.0%	33.3%	3.71(1.216)	43.515	203	<0,001

Respondents were asked if they could describe a time when they used DT to generate a new idea for an entrepreneurship venture. The responses grouped in Table 7 into various categories are detailed below:

No experience with Design Thinking (36.3%): Many respondents expressed their lack of experience with DT. They mentioned that they had never used it before or were unsure about it. Some acknowledged the importance of creativity in entrepreneurship but had not yet applied DT in their ventures.

Design Thinking used in educational assignments (23.5%): A significant portion of respondents shared that they had used DT in educational assignments, particularly in group projects. They cited instances where they applied DT to generate new business ideas, solve problems, or create innovative solutions as part of their coursework.

Entrepreneurial ventures (6.4%): A smaller group of respondents discussed using DT in the context of their entrepreneurial ventures. They mentioned using DT to identify market niches, define problems, and create unique business concepts. These individuals applied DT principles in real-world business scenarios.

Limited or unclear use of Design Thinking (3.9%): Some respondents had limited or unclear experiences with DT. They expressed curiosity about its potential impact but had not yet applied it in practical situations. Their responses suggested a desire to explore DT further.

Personal aspirations and reflection (4.9%): Several respondents shared personal aspirations and reflections related to entrepreneurship and DT. They expressed ambitions to start businesses, address societal problems profitably, and recounted moments when they considered innovative business ideas, often driven by a desire to make a positive impact on society.

Miscellaneous responses (1.0%): A few responses fell into the miscellaneous category, such as a suggestion for a feature in a music app. These responses were unrelated to entrepreneurship but still showcased the potential application of DT

Table 8: Summary of time Design Thinking can be used to generate a new idea for an entrepreneurship venture

Category	Direct statements	Frequency	Percentage
No experience with Design Thinking	-"I have never used design thinking." -"I've never used design thinking before." -"I've never used design thinking. -"I don't know anything about Design Thinking as yet." -"I haven't used it, but I know entrepreneurship needs creativity." -"I can use design thinking to generate new ideas for an entrepreneurial venture during the initial stages of planning." -"I am not sure."	74	36.3%
Design Thinking used in educational assignments	-"I used design thinking in designing my new windbreaker jacket." -"I used design thinking to generate a new business idea which we were asked to, but it was a group assignment for Introduction to Technopreneurship module." -"I used design thinking when I was doing business management last semester." -"During a group assignment." -"During group assignment."	48	23.5%
Entrepreneurial ventures	-"Based on the insights gained from empathy, I defined a specific problem or opportunity within the sustainable fashion space." -"I had to find a niche in the market and find ways to execute differently than the already existing businesses in my community." -"I used design thinking the time I was doing a business Management module last semester. -"By developing a new sweet shop which offers a unique customer experience." -"I decided to sell prepared food for working people and delivered them to their doorsteps."	13	6.4%
Limited or unclear use of Design Thinking	-"Actually, I would say no because it is the first time and it seems like it has no impact so far but I am curious." -"Any time you are free." -"I didn't use it."	8	3.9%
Personal aspirations and reflection	-"Honestly, ever since I was 17 years old, I always think of starting major businesses, a huge company." -"I would have used design thinking to address solutions for the problem which occurs in the society but in a profitable way." -"I think I was still in high school and I was thinking if I go to varsity, I will have to start my own business." -"It was when I thought about this device that acted like teeth when placed in a woman's body, to help against rape." -"When I saw a show about entrepreneur on TV" -"When i have to think about a business I'm going to make, so that other people can like it." -"When I was starting my business." -"When I started my small business." -"When I used design thinking the business was a success."	10	4.9%
Miscellaneous responses	-"For YouTube music to continue playing a certain song even if you have exited the app."	2	1.0%
Total		**204**	**100.0%**

Suggestions for incorporating DT

Table 9 summary highlights the responses gathered from the question which aimed to understand how university programmes could better incorporate DT into their entrepreneurship curriculum. The suggestions provided by the respondents were categorised into different themes which are detailed below:

Curriculum integration (18.8%): Many of the respondents emphasized the need to incorporate DT into the university curriculum. The respondents suggested adding it as a module, making it compulsory, or integrating it into the existing entrepreneurship courses. They proposed the creation of dedicated DT courses and practical techniques rather than theory.

Awareness and promotion (10.4%): Respondents highlighted the importance of raising awareness about DT. They suggested hosting events, inviting industry experts for workshops and talks, and creating opportunities for discussions and gatherings. They emphasized the value of promoting DT as a module for every course to help students understand its significance.

Practical application (10.9%): Respondents revealed how students can apply DT in real-world scenarios. They proposed practical modules that encourage students to start businesses, collaborate, engage in thinking challenges, and sell products. Design Thinking also emphasizes a systematic approach to teaching problem-solving.

Student engagement and participation (11.9%): Respondents suggested that students should actively participate in programmes and collaborate across disciplines to bring diverse perspectives to DT. This encourages cross-functional teams to apply DT to entrepreneurial challenges.

Resources and support (5.9%): Here, respondents emphasized the importance of providing access to DT tools, software, and resources. They also stressed the need for funding and support for students to start businesses.

Miscellaneous (6.4%): Some respondents provided suggestions such as providing opportunities to apply DT to real-world problems, coming up with strategies and solutions, and making the process engaging.

No suggestion (7.4%): Some respondents expressed uncertainty or a lack of knowledge about how DT can be better incorporated into the curriculum, leading to the "no suggestion" theme.

The above narratives represent the different perspectives and ideas respondents have regarding the incorporation of DT into university entrepreneurship programmes.

Table 9: Summary of respondents' suggestions regarding incorporation of Design Thinking into University entrepreneurship programmes

Theme	Direct Quote	Frequency	Percentage
Curriculum Integration	Adding them more to some entrepreneurial modules. By adding it as a module or rather together with entrepreneurship module. By adding such modules and make them compulsory to students. By allowing all first-year student to do module like itch and having programmes where they will tell us more about design thinking. By introducing a module to students whereby they will be taught about design thinking. By making entrepreneurship are course. Courses should offer entrepreneur-based modules in order for students to be aware of Design Thinking. Create a Design thinking course. Introduction of practical techniques rather than theory. They should Design Thinking as a module. To better incorporate Design Thinking into entrepreneurship curriculum, universities could integrate real-world case studies, guest lectures from industry experts, and hands-on projects that emphasize user-centered problem-solving. Additionally, fostering interdisciplinary collaboration and providing access to design tools and resources would enhance students' ability to apply Design Thinking in entrepreneurial contexts. University can introduce dedicated design thinking courses within the entrepreneurship curriculum. These courses should cover key principles, methodologies, and tools of design thinking, such as empathy mapping, prototyping, and user testing. Students can learn to apply these techniques to real-world entrepreneurial challenges. University should make Design Thinking be part of every student module so that it should be understood better.	38	18.8%
Awareness and promotion	By designing programmes that makes us aware of the importance of design thinking. By hosting events that educate us more about it. Invite industry experts and practitioners who have successfully used Design	21	10.4%

	Thinking in entrepreneurship to conduct workshops or give talks. They could have workshops in every week. Or have a course that requires them to think and act like entrepreneurs. They could host weekly optional gatherings for discussions, and such. Almost like an online forum, except it's not as anonymous and is in person. It would be pretty good for people to bounce their thoughts, worries and solutions off of each other. They could include Design Thinking as a module for every course in the University for students to learn how they can be independent.		
Practical application	By adding a practical module. This module will promote and encourage students to creatively start a business, act on it, give a report for marks, while making extra cash or losses on the side. By allowing students to practice what they learn by providing them with the necessary resources. Make activities such as thinking challenges and competitions that incorporate design thinking. Encourage students to work as groups and reflect on their design thinking process. Make that section more involved and engaging. Making it fun. Students could use design thinking process based on their courses since we know that the rate of unemployment is very high in South Africa. They must allow students to sell their products while studying. They must create a market day holiday annually. Use a creative, systematic approach to teach problem-solving. Use unique techniques.	22	10.9%
Student engagement and participation	By encouraging Students to participate in programmes. Encourage students to collaborate across disciplines. Design Thinking benefits from diverse perspectives, so programmes could promote partnerships between business students and those in fields like engineering, design, or the social sciences. Encourage students to collaborate across disciplines. Partner with other departments like design, engineering, or psychology to create cross-functional teams that can apply Design Thinking to real-world entrepreneurial challenges. Encourage students to participate.	24	11.9%
Resources and support	Provide access to Design Thinking tools, software, and resources to support student projects and ideation processes. Provide funding so that it will be easy for students to start their own business. Providing support and funding.	12	5.9%
Miscellaneous	"Provide opportunities to apply Design Thinking principles to real-world problems." By coming up with more strategies, planning, and solutions on their entrepreneurship." "Making it a fun engaging process." "Making it a focal point	13	6.4%
No suggestion	"N/A", "No", "None", "I am not sure", "I don't know", "Not sure", "I don't know because I have not understood design thinking in deep detail", "I don't really know"	15	7.4%

Cross-disciplinary problem solving and innovation

Table 10 summary highlights the response to the statement "How do you think DT in other fields of study beyond entrepreneurship?" From the responses provided, the following were uncovered:

Innovation and problem solving (2.9%): Design Thinking is seen as a way to innovatively solve problems. It's described as a means of innovating and identifying solutions for crises in various studies. It can be applied to foster innovation and problem-solving in multiple contexts beyond entrepreneurship.

Education (2.0%): DT can be used in education to develop innovative teaching methods, create engaging learning experiences, and design educational tools and resources that meet the diverse needs of students. It can also help students think critically and potentially start their own businesses.

General application (0.5%): DT's adaptable nature was highlighted, making it a valuable tool in various fields where creativity, empathy, and problem-solving are important. It encourages a human-centered approach that can lead to meaningful outcomes in different disciplines.

Entrepreneurship focus (6.4%): DT is associated with creating more entrepreneurs, encouraging students to take charge, generate entrepreneurial ideas, and create value using their skills. It's also linked to helping businesses stay ahead through innovation, empowering graduates to start their own businesses, and financial success.

Uncertainty/Not sure (8.3%): Some responses express uncertainty about how DT can be applied in other fields, indicating a lack of clarity or confidence in its potential applications.

Applying Design Thinking in different fields (12.4%): DT is discussed in various fields, such as healthcare, fashion design, engineering, science, and more. It is seen to encourage innovative problem-solving, thinking outside the box, and addressing complex challenges in diverse domains.

Teaching and curriculum integration (2.9%): Some respondents suggest that DT should be included in every faculty and integrated into the curriculum to empower students with entrepreneurial skills and problem-solving abilities.

Political studies (1.0%): DT is mentioned by some of the respondents as applicable in political studies, where it can help address difficulties related to cooperation with other superpower countries.

High school and primary school (1.0%): DT is suggested as a valuable approach for primary and high schools, potentially helping students develop problem-solving and creative thinking skills from an early age.

Other fields (7.4%): Various responses propose the application of DT in specific fields or contexts, demonstrating its versatility in addressing unique challenges across a wide range of domains.

In summary, DT is perceived as a versatile approach that can be applied to foster innovation, problem-solving, and entrepreneurship in various fields, although there is some uncertainty about its applicability in some cases. It is also seen as a valuable tool for enhancing education, teaching methods, and curriculum development.

Table 10: Summary of cross-disciplinary problem solving and innovation Design Thinking can be applied beyond the entrepreneurial venture

Theme	Direct Quote	Frequency	Percentage
Innovation and problem solving	"A way to innovatively solve problems" "As a means of innovating" "By identifying the problem and solution for any crisis in that particular study. Makes innovation of other things." "Design thinking can be applied to various fields beyond entrepreneurship to foster innovation and problem solving"	6	2.9%
Education	"By educating people" "Design Thinking can be used to develop innovative teaching methods, create engaging and interactive learning experiences, and design educational tools and resources that meet the needs of diverse learners." "Can be used to assist students to think critically through practicals" "Can help students to start their own business when finishing their studies"	4	2.0%
General application	"Design Thinking's adaptable nature allows it to be a valuable tool in almost any field where creativity, empathy, and problem-solving are important. It encourages a human-centered approach that can lead to more meaningful and impactful outcomes across a wide range of disciplines."	1	0.5%
Entrepreneurship focus	"It could be use by creating more entrepreneurs" "By creating more entrepreneurs" "By taking charge and be owners" "Create ideas of entrepreneurship to students" "Creating value with their own skills" "It helps brands stay ahead of the curve by driving innovation in a business environment" "It can empower graduate by opening their own businesses."	13	6.4%

	"Lower because some students had never been doing business studies at high school" "You can make money and be successful" "You could use design thinking and your field of study to create a business venture"		
Uncertainty/Not sure	Various responses expressing uncertainty about how Design Thinking can be used in other fields.	17	8.3%
Applying design Thinking in different fields	"In healthcare, Design Thinking can be used to improve patient experiences, enhance healthcare delivery processes, and develop patient-centered solutions." "Incorporate it with the knowledge in your field" "It could be used by giving us an open mind by wanting to start a business related to the course we are doing" "It could be used in fashion designs, engineering, and many more." "It could be used in science when coming up with new ideas to solve problems" "It enables one to think outside the box and could help students find solutions and understand things better." "It will depend on the field" "It will help students have background information regarding entrepreneurship" "Students can determine the problem based on their field of study and try to come up with a solution that could be lucrative for them." "Design Thinking can be applied in various fields beyond entrepreneurship, such as healthcare, education, and product development, by encouraging empathy-driven problem identification and innovative solution ideation. Its user-centric approach can help address complex challenges across diverse domains."	25	12.4%
Teaching and curriculum integration	"It should be included in every faculty" "It should be used in all faculties because most of us like to be bosses of our own." "Teach it to later year students instead of 1st years because they have acquired more skills from their field of study" "There should be a module for design thinking" "Through Cornerstone and Communication modules. In fact, since DUT is highly ranked in SA as an institution that is doing well in Entrepreneurship. Design Thinking should be considered and added as a compulsory module for every field in DUT like Cornerstone"	6	2.9%
Political studies	"I think even in Political studies because politics faces a wide range of difficulties in the country where they have to co-operate with other superpower countries." "Politics is a suitable spot to use design thinking because we know that they have to deal with other superpower countries in order to co-operate."	2	1.0%
High school and primary school	"Should start at primary school" "I think they should be used in high schools also."	2	1.0%
Other fields	Various responses suggesting the application of Design Thinking in specific fields or contexts.	15	7.4%

Comparative analysis: Bootcamp vs. timetabled

Part of the research enquiry is to do a comparative study on students who have done an Entrepreneurship module following the DT format versus a more generic entrepreneurship programme which does not use DT in order to determine whether DT should be adopted as a teaching and learning strategy or not. This section aims to address this.

Table 11 shows the mean, standard deviation, and independent t-test of the respondents' ability to generate and execute new ideas based on their attending DT (Bootcamp) versus those who did not (timetabled). The data revealed that there was no statistically significant difference in confidence levels between those who attended the bootcamp and those who were part of the timetabled class for both generating and executing new ideas. Both groups express a moderate level of confidence in these abilities, with bootcamp attendees having slightly higher mean confidence scores, but the differences are not statistically significant ($P>0.05$).

Table 11: Confidence level of executing and generating news based on attending bootcamp and timetabled

	Did you attend the bootcamp (3-5 days) or Timetabled class (every week)	N	Mean	Std. Deviation	Std. Error Mean	t	df	P value
How confident do you feel about your ability to generate new ideas?	Bootcamp	23	3,61	0,988	0,206	0.981	202	0.328
	Timetabled	181	3,37	1,111	0,083			
How confident do you feel about your ability to execute on new ideas?	Bootcamp	23	3,57	1,080	0,225	1.487	202	0.139
	Timetabled	181	3,19	1,136	0,084			

Logistic regression

A logistic regression analysis was performed to examine the association between two predictor variables (attending a bootcamp or timetabled class and previously taking an entrepreneurship course) and starting entrepreneurship venture at university. The unadjusted (univariate) and adjusted (multivariable) odds ratios (OR), along with their 95% confidence intervals (95% CI) and p-values are reported in Table 12. The results reveal that for those who attended the bootcamp, the odds of the outcome (starting entrepreneurship ventures at university) are 1.20 times higher. However, this result is not statistically significant, as the p-value is 0.735. This suggests that there is no significant association between attending the bootcamp and the outcome. For those in the timetabled class, the odds of the outcome are 0.83 times lower. Again, this result is not statistically significant (p-value = 0.735), indicating no significant association. In the adjusted model, attending the bootcamp or timetabled class does not show a significant association with starting entrepreneurship venture at university (P=0.874).

For those who have previously taken an entrepreneurship course, the odds of starting entrepreneurship ventures at university are 3.95 times higher compared to those who have not taken such a course. This difference is statistically significant with a p-value of 0.000, indicating a strong association between taking an entrepreneurship course and starting entrepreneurship ventures at university. In the adjusted model, the odds ratio for having previously taken an entrepreneurship course is 3.3, with a 95% confidence interval ranging from 1.47 to 7.51. The p-value remains statistically significant (0.004), suggesting that even when accounting for other variables (age, sex, faculty, and level of study), the results indicate that there is a significant association between having previously taken an entrepreneurship course and starting entrepreneurship ventures at university (Malebana and Mothibi, 2023).

Discussion

The background information analysis revealed that a significant proportion of the participants were female. UNESCO (2020) suggests that shifting societal norms surrounding gender have facilitated an increase in the number of women pursuing higher education, leading to greater acceptance and support for women in academic and professional pursuits. On the other hand, older students may encounter financial challenges that could hinder their return to formal education. Typically, students transition to tertiary education immediately or shortly after completing their secondary schooling, which in many countries concludes around the age of 18. As a result, the average age of tertiary education entrants tends to fall within the 18-19 age range. This conventional educational pathway explains why the majority of students are under the age of 25 upon completion of their undergraduate studies (Altbach, Reisberg and Rumbley, 2019). The results highlight that while exposure to DT is relatively high in terms of awareness, practical application remains limited. Most students have not participated in DT workshops or entrepreneurial ventures. However, among those who have, DT is strongly associated with idea generation and perceived as a valuable entrepreneurial tool. This perspective is further supported by Robinson and Aronica (2015), who identified a tendency within educational institutions to prioritise standardized testing and memorisation techniques over fostering creative thinking and problem-solving skills.

As previously discussed in the Findings section, there was no statistically significant difference between bootcamp and timetabled class participants in terms of confidence levels. Despite limited hands-on experience, students showed moderate confidence in entrepreneurial skills. Importantly, prior entrepreneurship education, not DT format, was the most significant predictor of venture initiation. This aligns with Malebana and Mothibi

(2023), emphasising the importance of formal education in fostering entrepreneurial activity. This rapid testing process helps to alleviate the fear of failure and promotes a proactive approach to entrepreneurship (Hunter, Jenkins and Mark-Herbert, 2021).

Students suggested practical and curriculum-based integration of DT into entrepreneurship education, reflecting a need for interdisciplinary approaches, real-world application, and increased support. These insights can guide policy and curriculum development to improve entrepreneurial outcomes and innovation capacity in higher education. Tschimmel (2022) also supports the notion that DT proves beneficial in group projects, as it typically involves teamwork and collaborative efforts. Students benefit from collaborating, drawing upon a variety of perspectives, and collectively crafting solutions, mirroring professional settings and bolstering their teamwork skills. The use of DT outside of entrepreneurship is supported by its human-centered approach, interdisciplinary nature, iterative methodologies, emphasis on creativity and innovation, ability to navigate uncertainty, and consideration of ethical implications. These aspects are critical for addressing complex challenges across diverse fields and facilitating meaningful change (Tschimmel and Santos, 2018).

Conclusion

This study aimed to explore the integration of DT into entrepreneurship education at the university level. Through surveys, the study examined the relationship between participation in DT sessions, confidence levels, and involvement in entrepreneurial ventures among students. While the findings indicate a high awareness of DT, participation in DT-related workshops and courses was relatively low. The study also found that students exhibited moderate confidence in idea generation, with slightly higher confidence in generating ideas than in executing them. Interestingly, while DT did not result in statistically significant differences in students' confidence in generating or executing ideas, boot camp participants showed a slightly higher mean confidence score compared to those who attended timetabled classes. However, the differences in confidence were not significant ($P > 0.05$). Furthermore, the study revealed that although few students had started entrepreneurial ventures during their university years, those who had credited DT with inspiring their entrepreneurial ideas. This finding aligns with the results of the logistic regression analysis, which showed that while attending a boot camp or timetabled class did not significantly affect the likelihood of starting an entrepreneurship venture, previous exposure to an entrepreneurship course increased the odds of starting a business venture at university (OR=3.95, P=0.000).

The study concluded that DT holds great potential as an engaging and accessible tool to enhance entrepreneurship education. By promoting creativity, problem-solving, and resilience, DT fosters an entrepreneurial mindset and encourages multidisciplinary collaboration. The research also highlighted the need for greater integration of DT into curricula to increase student engagement and practical application. This could include incorporating DT into entrepreneurship courses or other academic disciplines where creativity and problem-solving are central. Considering the findings, future research could explore the long-term impact of DT training on entrepreneurial success beyond the university setting. Further studies could also investigate the effectiveness of different methods of incorporating DT into diverse academic disciplines, as well as its impact on students' entrepreneurial behaviour in various cultural and educational contexts. Additionally, exploring complementary strategies, such as mentoring or hands-on entrepreneurial experiences, may provide further insight into how DT can be better leveraged to support students in launching and growing entrepreneurial ventures.

Declarations

Interdisciplinary Scope: This study integrates entrepreneurship, design theory, and educational psychology to evaluate how Design Thinking enhances students' entrepreneurial mindset and innovation skills. By combining business development, creative problem-solving, and learner behaviour insights, the research offers a holistic view of how Design Thinking can be effectively embedded into university curricula.

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References

Akhmetshin, E. M., Romanov, P. Y., Zakieva, R. R., Zhminko, A. E., Aleshko, R. A. and Makarov, A. L. 2019. Modern Approaches to Innovative Project Management in Entrepreneurship Education: A Review of Methods and Applications in Education. *Journal of Entrepreneurship Education,* 22(1): 1-15.

Aldrich, H. 2019. Entrepreneurship. *Research in the Sociology of Work,* 15: 3-31.

Altbach, P. G., Reisberg, L. and Rumbley, L. E. 2019. Trends in Global Higher Education: Tracking an Academic Revolution. Available: https://atepie.cep.edu.rs/public/Altbach%2C_Reisberg%2C_Rumbley_Tracking_an_Academic_Revolution%2C_UNESCO_2009.pdf (Accessed 18 October 2023).

Auernhammer, J. and Roth, B. 2021. The Origin and Evolution of Stanford University's Design Thinking: From Product Design to Design Thinking in Innovation Management. *Journal of Product Innovation Management,* 38(6): 623-644.

Baker, T. and Welter, F. 2020. *Contextualizing Entrepreneurship Theory*. New York: Routledge.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M. and Rumble, M. 2012. Defining Twenty-First Century Skills. In: Griffin, P., McGaw, B. and Care, E. eds. *Assessment and Teaching of 21st Century Skills*. London: Springer, 17-66.

Dam, R. F. and Siang, T. Y. 2021. What Is Design Thinking and Why Is It So Popular? Available: https://www.interaction-design.org/literature/article/what-is-design-thinking-and-why-is-it-so-popular (Accessed 12 September 2023).

Daniel, A. D. 2016. Fostering an Entrepreneurial Mindset by Using a Design Thinking Approach in Entrepreneurship Education. *Industry and Higher Education,* 30(3): 215-223.

Forcher-Mayr, M. and Mahlknecht, S. 2020. A Capability Approach to Entrepreneurship Education: The Sprouting Entrepreneurs Programme in Rural South African Schools. *Discourse and Communication for Sustainable Education*, 11(1): 119-133.

Gamede, B. and Uleanya, C. 2019. Factors Impacting Entrepreneurship Education in TVET Colleges: A Case of South Africa. *Journal of Entrepreneurship Education,* 22(3): 1-12.

Griffin, K. A., Muñiz, M. M. and Espinosa, L. 2012. The Influence of Campus Racial Climate on Diversity in Graduate Education. *The Review of Higher Education*, 35(4): 535-566.

Hisrich, R. D., Peters, M. P. and Shepherd, D. A. 2018. *Entrepreneurship.* New York: McGraw-Hill.

Hunter, E., Jenkins, A. and Mark-Herbert, C. 2021. When Fear of Failure Leads to Intentions to Act Entrepreneurially: Insights from Threat Appraisals and Coping Efficacy. *International Small Business Journal*, 39(5): 407-423.

Kimbell, L. 2011. Rethinking Design Thinking: Part I. *Design and Culture,* 3(3): 285-306.

Kuratko, D. F. 2005. The Emergence of Entrepreneurship Education: Development, Trends, and Challenges. *Entrepreneurship Theory and Practice,* 29(5): 577-597.

Malebana, M. J. and Mothibi, N. H. 2023. Relationship between Prior Entrepreneurship Exposure and Entrepreneurial Intention among Secondary School Learners in Gauteng, South Africa. *Journal of Innovation and Entrepreneurship*, 12(1): 1-20.

Micheli, P., Wilner, S. J. S., Bhatti, S. H., Mura, M. and Beverland, M. B. 2019. Doing Design Thinking: Conceptual Review, Synthesis, and Research Agenda. *Journal of Product Innovation Management,* 36(2): 124-148.

Ndlovu, S. G., Radebe, T. N., Xulu, N. C. and Mlambo, V. H. 2023. Entrepreneurial Mindset as a Facilitator and Barrier to Entrepreneurship Development: The Mediating Role of Entrepreneurial Culture. *International Journal of Social Science Research and Review,* 6(9): 170-182.

Nkomo, S. M. 2015. Challenges for Management and Business Education in a "Developmental" State: The Case of South Africa. *Academy of Management Learning and Education,* 14(2): 242-258.

Robinson, K. and Aronica, L. 2015. Creative Schools: Revolutionizing Education from the Ground Up. London: Penguin UK.

Sarooghi, H., Sunny, S., Hornsby, J. and Fernhaber, S. 2019. Design Thinking and Entrepreneurship Education: Where Are We, and What Are the Possibilities? *Journal of Small Business Management*, 57: 78-93.

Shé, C. N., Farrell, O., Brunton, J. and Costello, E. 2022. Integrating Design Thinking into Instructional Design: The #OpenTeach Case Study. *Australasian Journal of Educational Technology,* 38(1): 33-52.

Tham, J. 2022. Pasts and Futures of Design Thinking: Implications for Technical Communication. *IEEE Transactions on Professional Communication*, 65(2): 261-279.

Tham, J. C. K. 2020. Engaging Design Thinking and Making in Technical and Professional Communication Pedagogy. *Technical Communication Quarterly,* 30(4): 392-409.

Tschimmel, K. and Santos, J. 2018. August. How Designers can Contribute to Education: Innovating Educational Systems through Design Thinking. Available: https://doi.org/10.1007/978-3-319-96071-5_219 (Accessed 15 April 2025).

von Thienen, J. P. A., Weinstein, T. J. and Meinel, C. 2023. Creative Metacognition in Design Thinking: Exploring Theories, Educational Practices, and their Implications for Measurement. *Frontiers in Psychology,* 14: 1-20.