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Editors

Treating problematic smartphone usage in the TikTok era: cultural dimension bias in the current research

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Abstract

As smartphone ownership has steadily increased there has been a rise in individuals that display Problematic Smartphone Use (PSU). Through a comprehensive literature review of PSU it quickly became evident that research into PSU intervention strategies such as Cognitive Behavior Therapy (CBT) and Digital Detox are focused on "collectivist cultures". However, "collectivist cultures", such as India and China, account for only 45% of the world's population, and omit North America, almost all of Europe, Africa and Australasia. Further, our literature review identified that PSU intervention strategies almost all focus on issues surrounding social media use and gaming. Beyond this over-focus on collectivist cultures, we also find that the advent of TikTok has fundamentally changed things. TikTok has a strategy of using AI to feed users short form video (SFV) content that they find interesting. This is a very different form of smartphone usage than before TikTok, and almost certainly leads to a different form of PSU. As such, it is not clear that CBT and Digital Detox strategies developed based on "collectivist cultures" and based on pre-TikTok consumption of social media and gaming is relevant or effective Using a grounded theory approach, this paper is the first to identify the issue of a tilt in the PSU literature and the accompanying CBT and Digital Detox strategies to "collectivist cultures", as well as the first to recognize the impact on these PSU treatments as a result of the "TikTok Era" and the resulting transition to SFV. The outcome is that a rethink and new research into PSU and accompanying treatments is needed.

Keywords: problematic smartphone use, cognitive behavioral therapy, digital detox, short form video, TikTok

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Treating problematic smartphone usage in the TikTok era: cultural dimension bias in the current research

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1. INTRODUCTION

With the steady increase of smartphone ownership and accessibility, Problematic Smartphone Use (PSU) is becoming more apparent within society (Auxier & Anderson, 2021). PSU can be defined as compulsive smartphone use that can lead to negative consequences during daily functioning in terms of productivity, social relationships, physical health, or emotional well-being (Horwood & Anglim, 2018). Interventions can be made in several ways to help remedy PSU, including the use of apps designed for the purpose, not using the smartphone at all, which is called Digital Detox (Baek, 2013), as well as techniques such as cognitive behavioral therapy (CBT). CBT is an individual therapy that is designed to identify and make changes to an individual's negative behaviors, and has been found to be promising in helping the habits that PSU may cause (Kim, 2013).

This paper begins with a basic review of the current state of research on PSU, and ways in which individuals might cope with PSU. From this initial review phase, we discovered two trends which are the core thesis of this paper: that current research on how PSU can be treated with CBT and Digital Detox may be missing important issues of culture that make such research less relevant across areas of the world beyond those most intensely covered in the literature; that current research on how PSU can be treated with CBT and Digital Detox is focused almost exclusively on traditional forms of social media, and gaming, which ignores the rapid and intensive shift to short form video (SFV) being the predominate way smartphone users spend their time online, exemplified by the rise of TikTok. As a result, the research on how to treat PSU needs a rethink or new research regarding PSU and accompanying treatments.

2. RESEARCH BACKGROUND

Problematic Smartphone Usage

Problematic Smartphone Usage (PSU) is a term that can group certain individuals into a specific category correlated to the way they use their smartphone and can manifest in different ways depending on the user. PSU can be seen in behaviors such as using the device while driving which has been correlated to increase in traffic collisions and has been investigated as early as 1992 through data on mobile phone distractions related to collisions while driving (Billieux et al., 2019; Sun & Jia, 2016; Violanti, 1998).

Dependency problems can impact smartphone users that rely on the device to achieve their desired goals (Li, 2017) and may influence certain social, behavioral, and affective (mood) problems and can be linked to addictive behavior amongst individuals (Chóliz, 2010; Csibi et al., 2018). Although PSU is linked to addictive behavior there has yet to be a standard cut off point to distinguish if an individual user is addicted or has reached a problematic level of use (Harris et al., 2020). Even though there is no standard cutoff to diagnose PSU, someone who may be exhibiting PSU can be identified as displaying the six core components of addictive behavior. These are salience, mood modification, tolerance, withdrawal symptoms, conflict, and relapse (Csibi et al., 2018). Table 1 below describes each of these terms in more detail in relation to problematic and addictive behavior towards smartphones.

Term	Definition
Salience	Overwhelming dominance and total preoccupation of smartphone use.
Mood Modification	Mood changes experienced directly using smartphones.
Tolerance	The increase over time of daily hours spent using smartphones.
Withdrawal Symptoms	Negative feelings when unable to engage in smartphone use.
Conflict	Intrapersonal and interpersonal problems arising from smartphone use.
Relapse	The reversion to addictive smartphone behavior after a period of abstinence.

Table 1: Definition Table, Source, Csibi et al., (2017)

The most significant predictors of PSU are time spent using the device, conscientiousness (wanting to fulfill your own duties), emotional stability, openness, and age (Griffiths et al., 2017). Specific app use by an individual, which means the individual is focused on a particular app, for example Facebook or TikTok, may be another indicator to PSU or smartphone addiction (Noë et al., 2019).

Even though there is limited research that addresses general prevalence of PSU within individuals as a whole or who is likely to be affected by problematic use, preschool children and young adults are at highest risk for smartphone related addicted behavior (Csibi et al., 2019). The most vulnerable age group for excessive smartphone use are adolescents between the ages of 14 to 18 years old (Csibi et al., 2019; Lemola et al., 2015). A data analysis of problematic use within populations of children and young people shows that one in four of the individuals included in the study exhibited PSU, and with these behaviors they also have greater odds of being in poorer mental health than someone that does not suffer from PSU (Sohn et al., 2019). Another survey found that about a third of UK adults surveyed said that they find it difficult to disconnect (OfCom, 2016). Pew Research center also found that almost half of U.S. adults reported that they "could not live" without their smartphone (Elhai et al., 2016; Smith, 2015).

Early studies on PSU show the potential correlations to anxiety disorders, personality disorders, depressive disorders, and excessive stress when problematic use is present in an individual (Griffiths et al., 2017; Sohn et al., 2019), and more time spent on smartphones can lead to increase in anxiety (Griffiths et al., 2017). Results from research on anxiety and computers found anxiety was most related to PSU and that when one's smartphone usage increases their depression decreases and vice versa (Elhai et al., 2016). The inverse relationship of depression with smartphone use was a pattern found in many studies displaying the dependency of an individual when PSU is present and it can be further described as an individual's perceived depression increasing when they are unable to use their smartphone (Elhai et al., 2016). Younger individuals are at the highest risk of problems developing from PSU with many of the symptoms in these populations consisting of depression, anxiety, high levels of perceived stress, and poor sleep (Sohn et al., 2019). Social interactions are also impacted by the prevalence of PSU, envy was a risk factor mediated from fear of missing out that is created through PSU use in adolescent individuals. Envy in this circumstance is when the individual is jealous of what they see other people experiencing through their device (Wang et al., 2019).

Although there is limited research on which smartphone apps are causing problematic use or are the most addictive, social media apps like Snapchat show their correlation to PSU (Noë et al., 2019). Based on an indicator called Smartphone Application Based Addiction Scale (SABAS), which uses the six core components of addiction as discussed earlier as measurement, excessive users of social media apps and gaming are more likely to develop addiction symptoms than individuals that use their smartphones for productive tasks such as school or work purposes (Csibi et al., 2019).

Coping With Problematic Smartphone Use (PSU)

With PSU impacting certain individuals in the digital era, how to cope with it is an important topic. Research on coping with PSU is extensive, and within it we found two mechanisms that are more prevalent: 1) remedies such as Cognitive Behavioral Therapy (CBT), which is an individual therapy that is designed to identify and make changes to an individual's negative behaviors and may be an effective way of coping with PSU (Kim, 2013), and 2) apps designed specifically to intervene during long periods of smartphone use, which is called Digital Detox (Baek, 2013).

CBT "is a common type of talk therapy (psychotherapy). You work with a mental health counselor (psychotherapist or therapist) in a structured way, attending a limited number of sessions. CBT helps you become aware of inaccurate or negative thinking so you can view challenging situations more clearly and respond to them in a more effective way" (Mayo Clinic, 2019). CBT may be effective in dealing with PSU use as it has been found to help a multitude of habits. For instance, it can assist a person with an internet addiction to recognize the thoughts and feelings that are leading to their addictive behavior (Kim, 2013; Orzack & Orzack, 1999). In another study analyzing the impact of mind-body exercise (defined in this setting as gentle movement, anatomic alignment, mental focus, deep breathing, and staying in a meditative present state) and CBT, it was found that both to be useful in combating PSU as well as promoting good overall mental health (Thomas et al., 2020). In a controlled study completed on a group of individuals ages 12-19 that used an adapted form of CBT to target excessive smartphone use, the individuals showed a reduction in their excessive smartphone use after the therapy as well as an improvement in their psychological well-being (Khalily et al., 2021). This improvement in psychological well-being included a significant decrease in symptoms of depression, anxiety, stress, hyperactivity, and emotional difficulties immediately following the trial and this decrease maintained during the 3-month follow-up. In this case, excessive smartphone use follows a similar meaning to PSU as defined earlier correlating with the same impacts for each including increased risk of depression and anxiety, higher perceived stress, and poorer sleep in these individuals with these excessive or problematic behaviors (Horwood & Anglim, 2018; Khalily et al., 2021; Sohn et al., 2019). CBT has been found to be effective in treating individuals that exhibit these psychological issues and could be a gateway into helping change the habits of problematic smartphone users (Kim, 2013).

With the large potential effect on the youth since younger individuals are more likely to become problematic smartphone users', other intervention techniques are worth discussing (Sohn et al., 2019). Digital interventions, which are smartphone apps that are created to help reduce smartphone usage, could be promising if they become popular enough (van Velthoven et al., 2018). One study focused on the impact of an app that was created to show an individual their usage statistics and ways to limit their usage behaviors with a goal of self-regulation of smartphone use shows the efficacy of such an app. The results show that individuals using this app had a significant decrease in usage as well as their ability to manage interruptions was greatly improved (Ko, Yang, et al., 2015). However, there is a lack of empirical evidence that proves the safety and effectiveness of digital interventions through smartphone apps (van Velthoven et al., 2018). Due to individual subjective differences to their use (varying experiences produced by different users) the effectiveness of an application is difficult to find because of the inability to tailor the application to each person's specific psychological needs (van Velthoven et al., 2018).

Another approach that is being examined to help with addictive behaviors that are caused by smartphone use and other internet technology is a Digital Detox, which can be defined as a periodic disconnection from social or online media, or strategies to reduce digital media involvement (Syvertsen & Enli, 2020). The apps described earlier for digital interventions can be viewed in a similar way to digital detox because of their goal to reduce digital media in a user (Ko, Choi, et al., 2015; Syvertsen & Enli, 2020; van Velthoven et al., 2018). A study completed on digital detox, which in this case was four sessions of 24-hour smartphone abstinence, shows that there is a slight improvement in mood during periods of abstinence, but the overall results displays that there was not much change in behavior in heavy smartphone users (Wilcockson et al., 2019). Another study showed digital detox can lead to a decrease in smartphone usage and a decrease in depression symptoms after completing the intervention (Radtke et al., 2022). Though more studies are starting to be done on impacts of digital detox on PSU it is still rather a grey area and results appear to display a lack of effectiveness on the behaviors of the problematic users that are subjected through a digital detox intervention (Radtke et al., 2022; Wilcockson et al., 2019).

Studies on Coping with PSU are predominately focused on a small cross-section of global populations

In our review of studies on coping with PSU we noticed that the majority of the research was focused on a small cross-section of global populations. This is not a criticism of the research in and of itself. We are confident that the published research is thorough, informative, useful and interesting. Our point here is that there are known differences between the ways populations use and process cultural values and practices, and there is support in the literature for the fact that this has an impact on the efficacy of remedies such as Cognitive Behavioral Therapy (CBT). Although we conducted a thorough search, we were not able to locate studies about cross-cultural or cross-country similarities or differences for apps designed specifically to intervene during long periods of smartphone use (Digital Detox).

This is classic grounded theory approach to conducting research. Grounded theory is a qualitative research methodology that aims at the generation of theory from the literature, treating the body of existing studies as the data. Charmaz's (2006) constructivist perspective emphasizes the co-construction of meaning between the researcher and the data. When applied in the context of a literature review, grounded theory reconceptualizes the body of existing studies as data, facilitating the emergence of novel theoretical insights (Breckenridge & Jones, 2009; Mills et al., 2006; Tie et al., 2019). Unlike deductive approaches that test pre-established hypotheses, grounded theory employs an inductive process where data collection and analysis occur simultaneously (Charmaz, 2006; Glaser & Strauss, 2017). This iterative approach allows researchers to identify patterns, themes, and relationships within the literature, enabling the development of theory directly informed by the reviewed studies (Breckenridge & Jones, 2009; Charmaz, 2006; Mills et al., 2006). In the context of a literature review, grounded theory serves as both a methodological foundation and an analytical tool, an approach for exploring dynamic or complex phenomena, especially where existing theoretical frameworks may fall short in capturing emerging dynamics (Charmaz, 2006; Glaser & Strauss, 2017; Mills et al., 2006). Grounded theory has been employed in numerous studies in the field of Information Systems to address evolving phenomena.

Building off our grounded theory insight, we are first going to introduce two theories for looking at the ways different cultures might interact differently with CBT and Digital Detox: Hofstede's Cultural Dimensions Theory and the Theory of Cognitive Styles.

Hofstede's *Cultural Dimensions Theory* (Hofstede, 1984) is a framework for cross-cultural communication that shows the effects of a society's culture on the values of its members, and how these values relate to behavior. As CBT and Digital Detox are behavioral interventions, we believe that it is likely that the use of these as an intervention for PSU is likely going to vary across countries and cultures.

Witkin's *Theory of Cognitive Styles* (Witkin et al., 1977) "is a person's preferred way of gathering, processing, and evaluating information. It influences how people scan their environment for information, how they organize and interpret this information, and how they integrate their interpretations into the mental model and subjective theories that guide their actions" (Hayes & Allinson, 1998). As with Hofstede's Cultural Dimensions Theory, we believe that since CBT and Digital Detox are behavioral interventions, different cognitive styles across cultures and countries may impact the efficacy of these interventions.

In order to validate our contention that the majority of research on PSU with interventions of CBT and Digital Detox is focused on a small cross-section of global populations, we use a recent narrative review on combatting digital addiction and the countermeasures proposed (Cemiloglu et al., 2022) which reviews papers on this topic over the period 2012 to 2022. In addition, the Cemiloglu, et al. (2022) review finds that six scales have been used to screen research participants for mobile phone or smartphone addiction (see Appendix A for the six scales).

The Cemiloglu, et al. (2022) review cites 17 papers that use CBT as a PSU countermeasure approach. These papers are included in Table 2, along with the location of the study covered by the research, and whether or not one of the six screening for mobile or smartphone addiction scales was used.

Excluding the one paper that is a review paper of the literature, CBT as a countermeasure approach to digital addiction was studied 4 times in China (25%), 3 times in South Korea (18.75%), 3 times in Germany (18.75%), and once each in Spain, Pakistan, Iran, Austria and the USA (6.25%) (note, one study covered Germany and Austria, so the total adds up to more than 100%). When the list is narrowed to those studies where the research participants were selected based on mobile or smartphone addiction surveys, there are 4 in total, with 2 from South Korea, 1 from China and 1 from Pakistan.

The Cemiloglu, et al. (2022) review cites nine papers that use Digital Detox in the form of limit setting as a countermeasure approach. These papers are included in Table 3, along with the location of the study cover by the research, and whether or not one of the six screening for mobile or smartphone addiction scales was used.

Excluding the one paper that used downloads from the Google Play store for data (and therefore did not report country of the participant), Digital Detox from limit setting as a form of digital addiction countermeasure was the location of the study four times (50%) in South Korea, and one time in each of Japan, India and the USA (33%), with one study being across the world though predominately from Asia.

We next map the locations where the research was conducted with CBT or Digital Detox countermeasures onto the Hofstede's Cultural Dimensions (Hofstede, 1984) framework. We have combined countries, such as Austria - Germany, and China – South Korea – Japan, where the three Hofstede dimensions of Individualism – Collectivism, Power Distance and Uncertainty Avoidance are the same. The intent here is to show whether or not there are concentrations of research around specific types of cultural dimensions.

In Table 4, we summarize three dimensions of Hofstede's Cultural Dimensions Theory (Hofstede,

1984) showing the effects of a society's culture on the values of its members, and how these values relate to behavior. The dimensions are Individualism-Collectivism, Power Distance, Uncertainty Avoidance. We map these to the relevant research on CBT or Digital Detox countermeasures.

In the US, there is a high level of individualism, leading to a focus on Personal achievement, Independence, and Self-expression. This can manifest itself as regards to CBT as being something that is acceptable, and indeed easy to talk about, as therapy is about Independence, and Self-expression. In contrast, countries such as China, South Korea and Japan have a much more collectivist approach to culture with a focus on the values of its members, and how these values relate to behavior, leading to a focus on group consensus, social harmony and interdependence. This suggests that CBT and Digital Detox might be more problematic as a choice of intervention in higher collectivism societies than higher individualistic societies.

We note that there is support in the literature for this contention. For instance, "there are persistent questions about the generalizability of CBTs to culturally diverse populations and whether culturally sensitive approaches are warranted" (Huey et al., 2023). This very recent research also notes that there is "a dearth of relevant trials" of the impact of cultural sensitivity within the context of CBT.

Reference number in Cemiloglu, et al. (2022)	Citation	Location of study	Participants screened based on mobile or smartphone addiction surveys?
[13]	Hou, Y., Xiong, D., Jiang, T., Song, L., & Wang, Q. (2019).	Social psychology course at Peking University, **China**	No
[28]	Alavi, S. S., Ghanizadeh, M., Mohammadi, M. R., Jannatifard, F., Esmaili Alamuti, S., & Farahani, M. (2021).	All students at Tehran, **Iran** universities in the academic year of 2018-19	No
[42]	Li, T., Cui, L., Ma, S., Zhang, S., Zheng, J., Xiao, J., & Zhang, Q. (2018).	Forty-two **Chinese** college students	Yes
[60]	Wölfling, K., Müller, K. W., Dreier, M., Ruckes, C., Deuster, O., Batra, A., & Beutel, M. E. (2019).	4 outpatient clinics in **Germany** and **Austria**	No
[61]	Seo, H. S., Jeong, E. K., Choi, S., Kwon, Y., Park, H. J., & Kim, I. (2020).	**Korea** University Ansan hospital between the ages of 10 and 24 year	Yes
[72]	Ke, G. N., & Wong, S. F. (2018).	**Malaysia**	No
[73]	Han, J., Seo, Y., Hwang, H., Kim, S. M., & Han, D. H. (2020).	**South Korea**	No
[74]	Wölfling, K., Beutel, M. E., Dreier, M., & Müller, K. W. (2014).	42 patients in **Germany**	No
[75]	González-Bueso, V., Santamaría, J. J., Fernández, D., Merino, L., Montero, E., Jiménez-Murcia, S., & Ribas, J. (2018).	Barcelona, **Spain**	No
[84]	Zhang, J. T., Ma, S. S., Li, C. S. R., Liu, L., Xia, C. C., Lan, J., & Fang, X. Y. (2018).	Beijing Normal University, **China**	No
[86]	Young, K. S. (2013). Treatment outcomes using CBT-IA with Internet-addicted patients. *Journal of behavioral addictions*, *2*(4), 209-215.	**USA**	No
[105]	Du, Y. S., Jiang, W., & Vance, A. (2010).	**China**	No
[106]	Lee, H., Seo, M. J., & Choi, T. Y. (2016).	**South Korea**	Yes
[107]	Kim, S., & Noh, D. (2019).	5 in **China** 3 in **Korea** 2 in **USA** 1 in **Germany** Survey of prior research	No
[108]	Khalily, M. T., Bhatti, M. M., Ahmad, I., Saleem, T., Hallahan, B., Ali, S. A. E. Z., & Hussain, B. (2021).	**Pakistan**	Yes
[109]	Szász-Janocha, C., Vonderlin, E., & Lindenberg, K. (2021).	**Germany**	No

Table 2: 17 papers extracted from Cemiloglu, et al. (2022) review that use CBT as a PSU countermeasure approach.

Reference number in Cemiloglu, et al. (2022)	Citation	Location of study	Participants screened based on mobile or smartphone addiction surveys?
[117]	Ko, M., Yang, S., Lee, J., Heizmann, C., Jeong, J., Lee, U., & Chung, K. M. (2015)	Google Play – smartphone intervention apps	N/A
[118]	Ko, M., Choi, S., Yatani, K., & Lee, U. (2016)	**South Korea**	No
[119]	Kim, I., Jung, G., Jung, H., Ko, M., & Lee, U. (2017)	**South Korea**	No
[120]	Löchtefeld, M., Böhmer, M., & Ganev, L. (2013)	**Asia** (53.5%), **North America** (16.5%) and **Europe** (14.5%)	No
[121]	Kim, J., Cho, C., & Lee, U. (2017).	**South Korea**	No
[122]	Yasudomi, K., Hamamura, T., Honjo, M., Yoneyama, A., & Uchida, M. (2021).	**Japan**	No
[123]	Hiniker, A., Hong, S., Kohno, T., & Kientz, J. A. (2016).	**USA**	No
[124]	Okeke, F., Sobolev, M., Dell, N., & Estrin, D. (2018)	**India**	No
[129]	Ko, M., Choi, S., Yang, S., Lee, J., & Lee, U. (2015).	**South Korea**	No

Table 3: 9 papers extracted from Cemiloglu, et al. (**2022**) **review that use Digital Detox in the form of limit setting as a countermeasure approach.**

We recognize that the Cemiloglu (2022) paper, which forms the core of our ground theory analysis, is from 2022. To address this, we performed a comprehensive review of the PSU literature since then. We found that Olson et al. (2023) conducted "A nudge-based intervention to reduce problematic smartphone use", which is a Digital Detox intervention. This was conducted in Canada, a Highly Individualistic society.

As a cross-check, we also mapped the relevant research on CBT and Digital Detox using Witkin's Theory of Cognitive Styles (Witkin et al., 1977). This theory integrates a person's interpretations into the mental model and subjective theories that guide their actions, and there is clearly overlap between Hofstede's Cultural Dimensions Theory (Hofstede, 1984) and Witkin's Theory of Cognitive Styles (Witkin et al., 1977). We do not present the results here as they provide the same country-based distribution of relevant research on CBT and Digital Detox as the Hofstede's Cultural Dimensions Theory in Table 4.

Location	Papers identified in Table 1 & 2	Hofstede's Cultural Dimension of Individualism / Collectivism	Hofstede's Cultural Dimension of Power Distance	Hofstede's Cultural Dimension of Uncertainty Avoidance
USA	1 CBT 1 Digital Detox	**Highly Individualistic** Prioritize: Personal achievement Independence Self-expression	**Low** Great emphasis on: Equality Independence Challenging authority	**Low** Greater emphasis on: Innovation, flexibility and adaptability
Austria Germany	1 CBT 3 CBT	**Moderately individualistic** Prioritize: Personal achievement Independence Self-expression	**Low** Great emphasis on: Equality Independence Challenging authority	**Moderate to High** Strong emphasis on: Tradition Rules Avoiding risk
Spain	1 CBT	**Moderately collectivistic** culture, with a strong emphasis on family, community, and social harmony	**Relatively high** power distance culture, with a strong respect for authority and hierarchy	**Relatively high** uncertainty avoidance culture, with a strong desire for structure and rules
Malaysia	1 CBT	**More collectivistic** Prioritize: Social Harmony Interdependence, Group consensus	**High** Strong emphasis on: Respecting authority Social Status Hierarchy	**Moderate to High** Strong emphasis on: Tradition Rules Avoiding risk
India Pakistan	1 Digital Detox 1 CBT	**More collectivistic** Prioritize: Social Harmony Interdependence, Family loyalty	**High** Strong emphasis on: Respecting authority Social Status Hierarchy	**High** Strong emphasis on: Regulations Rules Avoiding risk
China South Korea Japan	4 CBT 3 CBT 4 Digital Detox 1 Digital Detox	**More collectivistic** Prioritize: Social Harmony Interdependence, Family loyalty	**High** Strong emphasis on: Respecting authority Social Status Hierarchy	**High** Strong emphasis on: Tradition Rules Avoiding risk

Table 4: Mapping the relevant research (Cemiloglu et al., 2022) on CBT or Digital Detox countermeasures against the main three dimensions of Hofstede's Cultural Dimensions Theory

	Individualism/Collectivism	Power Distance	Uncertainty Avoidance	CBT / Digital Detox papers
USA	Highly individualistic	Low	Low	2
Austria / Germany	Moderately Individualistic	Low	Moderate	4
Spain	Moderately Collectivistic	Relatively High	Relatively high	1
Malaysia	More Collectivistic	High	Moderate	1
India / Pakistan	More Collectivistic	High	High	2
China/South Korea/Japan	More Collectivistic	High	High	12
				22

Table 5: Mapping the relevant research (Cemiloglu, et al., (2022) – 22 papers) on CBT or Digital Detox countermeasures against the main three dimensions of Hofstede's Cultural Dimensions Theory

Table 5 shows that 16 out of 22 (73%) papers on treating PSU with CBT and Digital Detox were in high to moderately highly collectivist societies. This leaves us to conclude that there is support for our theory that current research on CBT and Digital Detox may be missing important issues of culture that make such research less relevant across areas of the world beyond those most intensely covered in the literature.

3. DISCUSSION

TikTok Time: Studies on Coping with PSU are predominately focused on traditional Social Media

In addition to the fact that many studies on PSU and coping with PSU through CBT and Digital Detox are country-specific and largely in countries with a more collectivistic cultural outlook which prioritizes Social Harmony, Interdependence, and Family loyalty, in our review of studies on coping with PSU we noticed that the majority of the research was focused on the use and interaction with traditional social media (Twitter, Facebook, Snapchat, Instagram) on PSU on smartphones. This makes sense as much of this research was conducted in an era when social media (Twitter, Facebook, Snapchat, Instagram) accounted for significant monthly active users, and for significant growth. Chart 1 shows the month active users and associated growth for Twitter, Facebook, Snapchat, and Instagram from 2013 to 2023. We note that use of YouTube, a video sharing platform, had a steady increase in monthly active users over this period, whereas Facebook and Snapchat are plateauing in their monthly active users, which suggests a move in users away from social interaction on traditional social media platforms, to videos for entertainment.

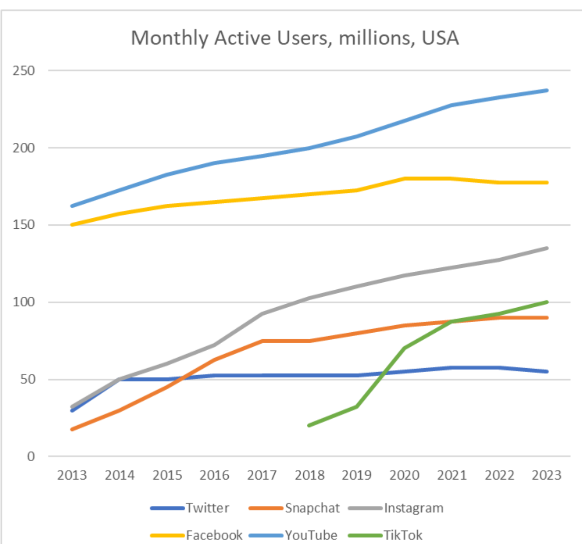

Chart 1: Data sourced from The Economist, 2023

Possibly more important than users when it comes to PSU, though, is the time spent per day on a smartphone with a particular app. Chart 2 maps out time spent per day, in minutes, on TikTok, Instagram, Snapchat and Facebook. As the chart shows, time spent with TikTok far exceeds Facebook, Snapchat and Instagram, and is almost the same as Snapchat and Instagram combined. Facebook use is trending down, Snapchat and Instagram is level, and TikTok use is growing from ~12 minutes per day in 2019 to ~60 minutes per day in 2023, a 5-fold increase.

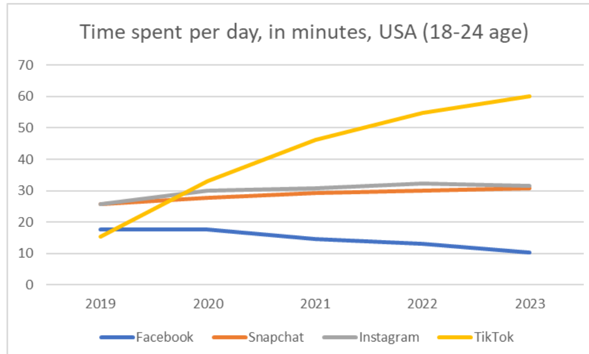

Chart 2: Data sourced from The Economist, 2023

As a cross-check, we conducted an informal survey of 50 students in our Management Information Systems classes at the 200- and 400-level (with median age of 20.2 in the 200-level class and 21.6 in the 400-level class). We had students report the data by checking their "Digital Wellbeing" in their Android device or "Screen On Time with a specific focus on apps" for iPhones.

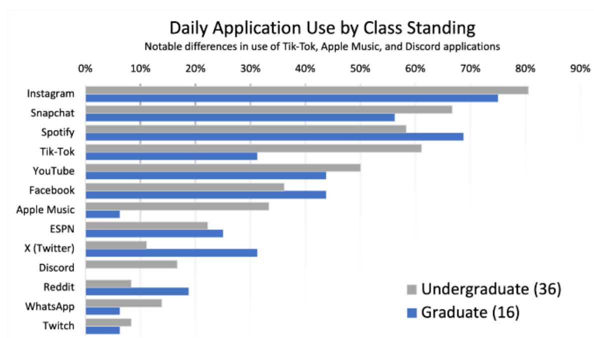

Chart 3: Daily app use by undergraduate class standing

In addition, we asked a follow-up question about the specific use of Instagram: "Are you watching videos or looking at photos?" Almost 80% of students reported that their main use of Instagram was to watch videos. This is important as it highlights a major change in the way people, specifically students in this case, are engaging with the apps on their smartphones. In the past it was for traditional social media, for which the main purpose was for social connection, and the main mental health issue was *fear of missing out (FOMO)* (Amran & Jamaluddin, 2022). The rise of TikTok and YouTube (Chart 1) and more importantly the rise in time spent on TikTok and YouTube (Chart 2) has changed how people engaged with their smartphones. There has been a move away from social networking, and instead to entertainment. The fact that Spotify, an app focused exclusively on music, is the number two most used app for our students (Chart 3) confirms that apps-for-entertainment is a big part of how people engage with their smartphones today.

According to TikTok itself, TikTok isn't a traditional social media platform: "The audiences that love and build and create and connect with TikTok, they say they check Facebook, and they check Instagram and they check Twitter and they check Snap and they check things. But they don't check TikTok. They tell us they watch TikTok" (Honigman, 2022). What we are seeing is that TikTok is more of an entertainment platform, where the entertainment is delivered via short form video. Facebook has recognized this change in user behavior from connecting socially to wanting to be entertained. In response to TikTok, Facebook introduce Reels "as its answer to the explosively popular short-video app TikTok" (Culliford, 2022). They note in 2022 that "Reels is already our fastest growing content format by far" and that "video now accounts for half of the time people spend on Facebook" (Culliford, 2022). We feel that this means that we need to look at PSU interventions around "entertainment" on smartphones as opposed to use of traditional social media on smartphones.

Coping with PSU as a result of short form video use

In addition to research about the use and abuse of social media on smartphones, there is a good deal of research around gaming on smartphones. For example, in a narrative review on approaches to combat digital addiction, the majority of studies delivered countermeasures for Internet Gaming Disorder (Cemiloglu et al., 2022). However, we posit that gaming is very different to the short form videos (SFV) that provide entertainment which form the core of what TikTok delivers. Gaming is typically interactive (Baker et al., 2021). Watching short form videos, in contrast, is a passive, receptive activity.

Research on short form video is extremely limited. This makes sense as one could argue that TikTok defined the short form video format, and TikTok only became globally available in August 2018 (Wikipedia "TikTok," 2025). We found zero articles using the following Google Scholar search term: "using cognitive behavioral therapy as an intervention for short form video addiction". Even searching for just "Short form video" yielded very few results, a confirmation that this entertainment format is a new phenomenon.

One such study looked at "the association between perceived stress and SVA [short form video] addiction, as well as its mechanism—the mediating role of self-compensation motivation (SCM) and the moderating role of shyness" (Liu et al., 2021). This does not address smartphone addiction in particular (short form videos can be watched on many platforms including TV and laptop), but we do note that it was conducted on a "total of 896 Chinese college students", furthering our findings that much of the research in this area is specific to a county with a collectivist cultural dimension.

Another study addressing short form video looked at how the "information system environment affects users' internal states of enjoyment, concentration, and time distortion (which scholars define as the flow experience)" (Qin et al., 2022). This study finds that "TikTok addiction is determined by users' mental concentration on the medium and its content" but does not address the use of CBT or Digital Detox. We note again that the study was conducted on "659 adolescents in China aged between 10 and 19 years old".

In a study exploring stress and problematic use of Short-Form Video Applications (Huang et al., 2022) showed that stress was positively associated with problematic SVAs use. The paper did not suggest intervention strategies, and was conducted on 194 middle-aged adults from China.

Liu et al. (2021) examined perceived stress and short-form video application addiction and found that perceived stress was positively associated with SVA. They note that their research could provide suggestions for relevant prevention and intervention procedures, but do not cover this aspect. The study was conducted on a "total of 896 Chinese college students".

Finally, Zhang et al. (2019) looked at what factors affected addition to short form video apps. They found that "social interaction anxiety and social isolation were … positive influences on short-form video app addiction". There was no discussion of possible treatments such as CBT or Digital Detox, and we once again note that the study was conducted on users of TikTok in China.

With short form videos as provided by TikTok, and also by Instagram, YouTube Shorts and Facebook Reels, being a passive, receptive activity, we liken them closest to TV. TikToks, YouTube Shorts, Facebook Reels and Instagram videos, whose most common length is 26 seconds, according to Instagram (Adobe, n.d.) are, in effect, just short television shows.

Accordingly, we posit that addressing smartphone addiction in the era of TikTok should commence with a review of the scholarly work on TV addiction. As a gauge of this line of research, we looked at Google Trends for "TV addiction". Google Trends starts from Jan 1, 2004 only (Chart 4). The peak at that time likely is an artifact of how the data is aggregated, that is, we do not believe that there was a massive spike in Google searches for "TV addiction" in January 2004, but rather all pre-January 2004 data is aggregated to January 2004. What the trend chart does show is that there has been little to no real activity in this space for almost 2 decades.

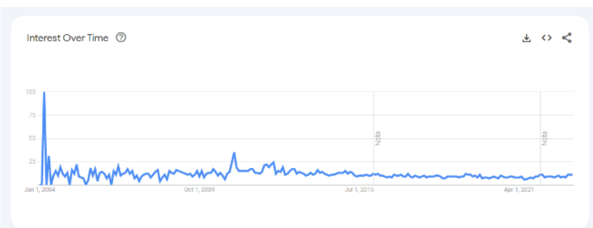

Chart 4: Google searches for "TV addiction" since 2004

We are confident that television addiction falls in the same realm as short-form video addiction, as it is measured with the distinct components of heavy viewing, problem viewing, and craving for viewing (Horvath, 2004). With this as a starting point, we then explored the literature for how to treat TV addiction, with the notion that such treatments could be translated into the short-form video addiction arena.

A seminal piece by Sussman & Moran (2013) "provide[s] a review of the definition, etiology, prevention and treatment of the apparent phenomenon of television addiction." Relevant to PSU and short-form video addiction, the authors found that "counseling that attempts to facilitate a secure attachment style with others may help delimit reliance on television as a form of passive social contact", and also that "mood management techniques might be instructed to reduce the desire to search out external sources of relief such as the TV". Both of these suggestions are elements of CBT and thus provide an indication that CBT might be an appropriate intervention for PSU and short-form video addiction.

A 2004 article by two of the pioneers of research on television addiction (Kubey & Csikszentmihalyi, 2004) noted that interventions for such included "promoting alternative activities" and "exercising willpower". They also noted digital detox interventions such as "enforcing limits" and "blocking channels/V-chip" use. A 1991 article noted, briefly, that "researchers are often asked how to break the television habit", and noted that there are few empirical studies for comparing methods for reducing excessive television viewing, but there are number of published accounts "based on common sense or generalizations from self-control techniques to gaining control over other habits" (McIlwraith et al., 1991).

5. CONCLUSIONS

The original purpose of this review was to show what Problematic Smartphone Use is, who it impacts, and ways in which it impacts individuals, with a focus on job and academic performance. During our review we pivoted to a grounded theory approach, and found that there were two issues at play with the extant research. Firstly, the vast majority of papers on treating PSU with CBT and Digital Detox were performed on subjects in collectivist (Hofstede, 1984) countries: China, India, Pakistan, Japan, Indonesia. The literature already suggests that "there are persistent questions about the generalizability of CBTs to culturally diverse populations and whether culturally sensitive approaches are warranted" (Huey et al., 2023). Combining our first finding with these "persistent questions" suggests that the current research on PSU and treating it with CBT and Digital Detox is far too myopic in scope, and needs to be broadened to populations that have high individualistic natures, such as the USA, western Europe, Africa, and Australasia.

Secondly, we realized that the vast majority of papers on PSU and treating it with CBT and Digital Detox were looking at issues related to traditional social media use and gaming as the cause of PSU. We have labelled this the pre-TikTok era, as the arrival of TikTok in August 2018 has led to a fundamental change in how people use their smartphones. Watching short form videos is a passive, consumptive activity, very different from engaging in social media dialogue. As such, we believe that interventions such as CBT and Digital

Detox, and their efficacy, need to be studied anew in the TikTok era.

In sum, this paper is a call to future research action around these two findings.

5. REFERENCES

Adobe. (n.d.). *Editing Videos for Instagram for Free | Adobe Express*. Retrieved February 7, 2025, from https://www.adobe.com/express/create/video/instagram

Amran, M. S., & Jamaluddin, K. A. (2022). Adolescent Screen Time Associated with Risk Factor of Fear of Missing Out During Pandemic COVID-19. *Cyberpsychology, Behavior, and Social Networking*, *25*(6), 398–403. https://doi.org/10.1089/cyber.2021.0308

Auxier, B., & Anderson, M. (2021). Social media use in 2021. *Pew Research Center*, *1*(1), 1–4.

Baek, R. (2013, July 5). At Tech-Free Camps, People Pay Hundreds To Unplug. *NPR*. https://www.npr.org/sections/alltechconsidered/2013/07/05/198402213/at-tech-free-camps-people-pay-hundreds-to-unplug

Baker, J. M., Bruno, J. L., Piccirilli, A., Gundran, A., Harbott, L. K., Sirkin, D. M., Marzelli, M., Hosseini, S. M. H., & Reiss, A. L. (2021). Evaluation of smartphone interactions on drivers' brain function and vehicle control in an immersive simulated environment. *Scientific Reports*, *11*(1), 1998. https://doi.org/10.1038/s41598-021-81208-5

Billieux, J., Flayelle, M., Rumpf, H.-J., & Stein, D. J. (2019). High Involvement Versus Pathological Involvement in Video Games: A Crucial Distinction for Ensuring the Validity and Utility of Gaming Disorder. *Current Addiction Reports*, *6*(3), 323–330. https://doi.org/10.1007/s40429-019-00259-x

Breckenridge, J., & Jones, D. (2009). Demystifying theoretical sampling in grounded theory research. *Grounded Theory Review*, *8*(2). https://www.researchgate.net/profile/Helen-Scott-11/publication/285789198_Data_Analysis_Getting_conceptual/links/5c09154792851c39ebd7719a/Data-Analysis-Getting-conceptual.pdf#page=64

Cemiloglu, D., Almourad, M. B., McAlaney, J., & Ali, R. (2022). Combatting digital addiction: Current approaches and future directions. *Technology in Society*, *68*, 101832. https://doi.org/10.1016/j.techsoc.2021.101832

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. sage. https://books.google.com/books?hl=en&lr=&id=2ThdBAAAQBAJ&oi=fnd&pg=PP1&dq=Charmaz,+K.+(2006).+Constructing+grounded+theory:+A+practical+guide+through+qualitative+analysis&ots=f-l_3LpECY&sig=WpItiXO_mB3zOmEH660dHtFsTrM

Chóliz, M. (2010). MOBILE PHONE ADDICTION: A POINT OF ISSUE. *Addiction*, *105*(2), 373–374. https://doi.org/10.1111/j.1360-0443.2009.02854.x

Csibi, S., Griffiths, M. D., Cook, B., Demetrovics, Z., & Szabo, A. (2018). The Psychometric Properties of the Smartphone Application-Based Addiction Scale (SABAS). *International Journal of Mental Health and Addiction*, *16*(2), 393–403. https://doi.org/10.1007/s11469-017-9787-2

Csibi, S., Griffiths, M. D., Demetrovics, Z., & Szabo, A. (2019). Analysis of Problematic Smartphone Use Across Different Age Groups within the 'Components Model of Addiction.' *International Journal of Mental Health and Addiction*, *19*(3), 616–631. https://doi.org/10.1007/s11469-019-00095-0

Culliford, E. (2022, February 22). Facebook launches Reels globally, betting on "fastest growing" format. *Reuters*. https://www.reuters.com/technology/facebook-launches-reels-globally-betting-fastest-growing-format-2022-02-22/

Elhai, J. D., Levine, J. C., Dvorak, R. D., & Hall, B. J. (2016). Fear of missing out, need for touch, anxiety and depression are related to problematic smartphone use. *Computers in Human Behavior*, *63*, 509–516. https://doi.org/10.1016/j.chb.2016.05.079

Glaser, B., & Strauss, A. (2017). *Discovery of grounded theory: Strategies for qualitative research*. Routledge. https://www.taylorfrancis.com/books/mono/10.4324/9780203793206/discovery-grounded-theory-barney-glaser-anselm-strauss

Griffiths, M. D., Kuss, D. J., Lopez-Fernandez, O., & Pontes, H. M. (2017). Problematic gaming exists and is an example of disordered gaming: Commentary on: Scholars' open debate paper on the World Health Organization ICD-11 Gaming Disorder proposal (Aarseth et al.). *Journal of Behavioral Addictions*, *6*(3), 296–301. https://doi.org/10.1556/2006.6.2017.037

Harris, B., Regan, T., Schueler, J., & Fields, S. A. (2020). Problematic Mobile Phone and Smartphone Use Scales: A Systematic Review. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.00672

Hayes, J., & Allinson, C. W. (1998). Cognitive Style and the Theory and Practice of Individual and Collective Learning in Organizations. *Human Relations*, *51*(7), 847–871. https://doi.org/10.1023/A:1016978926688

Hofstede, G. (1984). *Culture's consequences: International differences in work-related values* (Vol. 5). sage. https://books.google.com/books?hl=en&lr=&id=Cayp_Um4O9gC&oi=fnd&pg=PA13&dq=Culture%27s+Consequences:+International+Differences+in+Work-Related+Values+(2nd+ed.)&ots=V6EHAAPLP6&sig=UOgPCgjnNJElITi1YTSyclDdB0E

Honigman, B. (2022). TikTok isn'ta social media platform, according to TikTok. *Fast Company. Https://Www. Fastcompany. Com/90746981/Tiktok-Social-Video*.

Horvath, C. W. (2004). Measuring Television Addiction. *Journal of Broadcasting & Electronic Media*, *48*(3), 378–398. https://doi.org/10.1207/s15506878jobem4803_3

Horwood, S., & Anglim, J. (2018). Personality and problematic smartphone use: A facet-level analysis using the Five Factor Model and HEXACO frameworks. *Computers in Human Behavior*, *85*, 349–359. https://doi.org/10.1016/j.chb.2018.04.013

Huang, Y., Finsterwalder, J., Chen, N. (Chris), & Crawford, F. R. L. (2022). Online student engagement and place attachment to campus in the new service marketplace: An exploratory study. *Journal of Services Marketing*, *36*(4), 597–611. https://doi.org/10.1108/JSM-04-2021-0148

Huey, S. J., Park, A. L., Galán, C. A., & Wang, C. X. (2023). Culturally Responsive Cognitive Behavioral Therapy for Ethnically Diverse Populations. *Annual Review of Clinical Psychology*, *19*(Volume 19, 2023), 51–78. https://doi.org/10.1146/annurev-clinpsy-080921-072750

Khalily, M. T., Bhatti, M. M., Ahmad, I., Saleem, T., Hallahan, B., Ali, S. A.-Z., Khan, A. A., & Hussain, B. (2021). Indigenously adapted cognitive–behavioral therapy for excessive smartphone use (IACBT-ESU): A randomized controlled trial. *Psychology of Addictive Behaviors*, *35*(1), 93–101. https://doi.org/10.1037/adb0000677

Kim, H. (2013). Exercise rehabilitation for smartphone addiction. *Journal of Exercise Rehabilitation*, *9*(6), 500–505. https://doi.org/10.12965/jer.130080

Ko, M., Choi, S., Yang, S., Lee, J., & Lee, U. (2015). FamiLync: Facilitating participatory parental mediation of adolescents' smartphone use. *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, 867–878. https://doi.org/10.1145/2750858.2804283

Ko, M., Yang, S., Lee, J., Heizmann, C., Jeong, J., Lee, U., Shin, D., Yatani, K., Song, J., & Chung, K.-M. (2015). NUGU: A Group-based Intervention App for Improving Self-Regulation of Limiting Smartphone Use. *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*, 1235–1245. https://doi.org/10.1145/2675133.2675244

Kubey, R., & Csikszentmihalyi, M. (2004). Television Addiction. *Scientific American Mind*, *14*(1), 48–55.

Lemola, S., Perkinson-Gloor, N., Brand, S., Dewald-Kaufmann, J. F., & Grob, A. (2015). Adolescents' Electronic Media Use at Night, Sleep Disturbance, and Depressive Symptoms in the Smartphone Age. *Journal of Youth and Adolescence*, *44*(2), 405–418. https://doi.org/10.1007/s10964-014-0176-x

Li, L. (2017). *Work-related smartphone dependency among young working adults in urban China: An examination of the dependency relations, antecedents, and consequences* [Thesis]. https://doi.org/10.32657/10356/69610

Liu, Y., Ni, X., & Niu, G. (2021). Perceived Stress and Short-Form Video Application Addiction: A Moderated Mediation Model. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.747656

Mayo Clinic. (2019). *Cognitive behavioral therapy—Mayo Clinic*. https://www.mayoclinic.org/tests-procedures/cognitive-behavioral-therapy/about/pac-20384610

McIlwraith, R., Jacobvitz, R. S., Kubey, R., & Alexander, A. (1991). Television Addiction: Theories and Data Behind the Ubiquitous Metaphor. *American Behavioral Scientist*, *35*(2), 104–121. https://doi.org/10.1177/0002764291035002003

Mills, J., Bonner, A., & Francis, K. (2006). The Development of Constructivist Grounded Theory. *International Journal of Qualitative Methods*, *5*(1), 25–35. https://doi.org/10.1177/160940690600500103

Noë, B., Turner, L. D., Linden, D. E. J., Allen, S. M., Winkens, B., & Whitaker, R. M. (2019). Identifying Indicators of Smartphone Addiction Through User-App Interaction. *Computers in Human Behavior*, *99*, 56–65. https://doi.org/10.1016/j.chb.2019.04.023

OfCom, U. K. (2016). Children and parents: Media use and attitudes report. *London: Office of Communications London*.

Olson, J. A., Sandra, D. A., Chmoulevitch, D., Raz, A., & Veissière, S. P. L. (2023). A Nudge-Based Intervention to Reduce Problematic Smartphone Use: Randomised Controlled Trial. *International Journal of Mental Health and Addiction*, *21*(6), 3842–3864. https://doi.org/10.1007/s11469-022-00826-w

Orzack, M. H., & Orzack, D. S. (1999). Treatment of Computer Addicts with Complex Co-Morbid Psychiatric Disorders. *CyberPsychology & Behavior*, *2*(5), 465–473. https://doi.org/10.1089/cpb.1999.2.465

Qin, Y., Omar, B., & Musetti, A. (2022). The addiction behavior of short-form video app TikTok: The information quality and system quality perspective. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.932805

Radtke, T., Apel, T., Schenkel, K., Keller, J., & Von Lindern, E. (2022). Digital detox: An effective solution in the smartphone era? A systematic literature review. *Mobile Media & Communication*, *10*(2), 190–215. https://doi.org/10.1177/20501579211028647

Smith, A. (2015). *U.S. Smartphone Use in 2015*. https://policycommons.net/artifacts/619211/us/1600302/

Sohn, S. Y., Rees, P., Wildridge, B., Kalk, N. J., & Carter, B. (2019). Prevalence of problematic smartphone usage and associated mental health outcomes amongst children and young people: A systematic review, meta-analysis and GRADE of the evidence. *BMC Psychiatry*, *19*(1), 356. https://doi.org/10.1186/s12888-019-2350-x

Sun, D., & Jia, A. (2016). Impacts of cell phone use on driving safety and drivers' perception of risk. *Journal of Modern Transportation*, *24*(2), 145–152. https://doi.org/10.1007/s40534-016-0102-x

Sussman, S., & Moran, M. B. (2013). Hidden addiction: Television. *Journal of Behavioral Addictions*, *2*(3), 125–132. https://doi.org/10.1556/jba.2.2013.008

Syvertsen, T., & Enli, G. (2020). Digital detox: Media resistance and the promise of authenticity. *Convergence*, *26*(5–6), 1269–1283. https://doi.org/10.1177/1354856519847325

Thomas, J. J., Becker, K. R., Kuhnle, M. C., Jo, J. H., Harshman, S. G., Wons, O. B., Keshishian, A. C., Hauser, K., Breithaupt, L., Liebman, R. E., Misra, M., Wilhelm, S., Lawson, E. A., & Eddy, K. T. (2020). Cognitive-behavioral therapy for avoidant/restrictive food intake disorder: Feasibility, acceptability, and proof-of-concept for children and adolescents. *International Journal of Eating Disorders*, *53*(10), 1636–1646. https://doi.org/10.1002/eat.23355

Tie, Y. C., Birks, M., & Francis, K. (2019). *Grounded theory research: A design framework for novice researchers*. SAGE open medicine. https://figshare.utas.edu.au/ndownloader/files/40721888/1

TikTok. (2025). In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=TikTok&oldid=1273992507

van Velthoven, M. H., Powell, J., & Powell, G. (2018). Problematic smartphone use: Digital approaches to an emerging public health problem. *DIGITAL HEALTH*, *4*, 2055207618759167. https://doi.org/10.1177/2055207618759167

Violanti, J. M. (1998). Cellular phones and fatal traffic collisions. *Accident Analysis & Prevention*, *30*(4), 519–524. https://doi.org/10.1016/S0001-4575(97)00094-8

Wang, P., Wang, X., Nie, J., Zeng, P., Liu, K., Wang, J., Guo, J., & Lei, L. (2019). Envy and problematic smartphone use: The mediating role of FOMO and the moderating role of student-student relationship. *Personality and Individual Differences*, *146*, 136–142. https://doi.org/10.1016/j.paid.2019.04.013

Wilcockson, T. D. W., Osborne, A. M., & Ellis, D. A. (2019). Digital detox: The effect of smartphone abstinence on mood, anxiety, and craving. *Addictive Behaviors*, *99*, 106013. https://doi.org/10.1016/j.addbeh.2019.06.002

Witkin, H. A., Moore, C. A., Goodenough, D., & Cox, P. W. (1977). Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications. *Review of Educational Research*, *47*(1), 1–64. https://doi.org/10.3102/00346543047001001

Zhang, X., Wu, Y., & Liu, S. (2019). Exploring short-form video application addiction: Socio-technical and attachment perspectives. *Telematics and Informatics*, *42*, 101243. https://doi.org/10.1016/j.tele.2019.101243

Appendix A

In addition, the Cemiloglu, et al. (2022) review finds that six scales have been used to screen research participants for mobile phone or smartphone addiction: 1) Mobile Phone Addiction Index (Leung, L. 2008); 2) Smartphone Addiction Scale – short version (Kwon, M., Kim, D. J., Cho, H., & Yang, S. 2013); 3) Mobile Phone Internet Addiction Scale (Hu, D. D., Xu, Y., Ding, J. E., & Li, J. 2017); 4) Smartphone Addiction Inventory (Lin, Y. H., Pan, Y. C., Lin, S. H., & Chen, S. H. 2017); 5) Korean Smartphone Addiction Proneness Scale (Kim, D., Lee, Y., Lee, J., Nam, J. K., & Chung, Y. 2014); 6) Chinese Test of Mobile Phone Dependence (Li, T., Cui, L., Ma, S., Zhang, S., Zheng, J., Xiao, J., & Zhang, Q. 2018).

Blockchain Education: Evaluating Programs, Curricula, and Integration with Emerging Technologies in Higher Education

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Abstract

As blockchain technology, along with its convergence to other emerging technologies such as AI and the Internet of Things, shows promising pilot projects across industries, academic institutions are tasked with preparing students for careers in this rapidly evolving field. To address the growing demand for blockchain professionals, specialized educational programs have already been developed. This study examines the curricula of blockchain programs offered by universities with AACSB-accredited business schools in the US, highlighting their similarities and differences. Utilizing a dataset with 533 institutions, the research evaluates the scope of blockchain offerings, drawing from university websites and catalogs, and considering a broad range of disciplines, including computer science, business, and engineering. The findings reveal that approximately 28% of higher education institutions offer blockchain courses within their programs, addressing the interplay with emerging technologies and meeting industry needs for diverse competences. Key courses consistently included are Blockchain Technology Fundamentals, Smart Contract Development, and Cryptocurrency Economics. This study provides valuable guidance for academic institutions planning to introduce blockchain programs and offers a foundation for developing relevant curricula. By identifying commonalities and differences across blockchain and related fields, educators can design programs that prepare students to thrive in the blockchain sector. Additionally, this research acts as a resource for institutions striving to bridge the gap between traditional disciplines and the dynamic field of blockchain technology.

Keywords: Blockchain Education, Digital Learning, Interdisciplinarity, Distributed Ledger Technology.

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Blockchain Education: Evaluating Programs, Curricula, and Integration with Emerging Technologies in Higher Education

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1. INTRODUCTION

Blockchain technology has emerged as a transformative force across industries, promising enhanced security, transparency, and efficiency (see current industry projects here). However, its technological impact extends beyond these aspects, addressing not only economic sustainability but also embracing social and ecological dimensions (Schwarzer, Gürpinar, & Henke, 2022). From financial services to supply chains and healthcare, organizations are exploring the potential of blockchain to decentralize operations, establish audit trails for tracking environmental impact, and provide verifiable proofs of resource origins to uphold ethical practices (Grünewald, Gürpinar, & Culotta, 2024).

However, the adoption and effective integration of blockchain technology within enterprises remain a complex and challenging endeavor. In this era of dynamic digital innovations, the knowledge gap surrounding blockchain and connected technologies is striking. While businesses recognize the potential benefits of blockchain, there exists a significant disparity between this recognition and a comprehensive understanding of how to harness its power (Düdder et al., 2021) and move from proof-of-concepts to actual at scale solutions (Gürpinar, Henke, & Ashraf, 2024). According to recent surveys (Fomin, Gürpinar, & Baleviciene, 2024), Enterprises are struggling with fundamental questions: *Which competences are required to implement and later operate blockchain solutions?" How can employees acquire the necessary competences and expertise to navigate the evolving landscape around blockchains?*

This knowledge gap within enterprises is a critical issue that must be addressed (Malik, Chadhar, Chetty, & Vatanasakdakul, 2022). Without a skilled and well-trained workforce, the full potential of blockchain technology may remain untapped, hindering the competitiveness and innovation of organizations in an increasingly digital world. Bridging this gap requires a concerted effort to provide education in blockchain technology and equip the workforce with the necessary tools to harness its potential.

To this end, this paper sheds light on the state of blockchain technology programs in higher education. By examining the curricula of university programs, we aim to identify the existing landscape of academic blockchain education. The collection and comparison of data from higher learning institutions offering blockchain courses provide valuable insights into the structure, content, and focus of blockchain education. This research is a crucial step toward understanding how academic institutions are preparing students and professionals for careers in the blockchain industry. The need for this research becomes increasingly evident as the demand for blockchain expertise continues to grow as observed by Fomin at al. (2024). This is further demonstrated on LinkedIn, where approx. 4,000 blockchain jobs are advertised in the US. By examining the current academic offerings, we discern trends, commonalities, and distinctions among university programs teaching blockchain courses. This knowledge will serve as a foundation for improving existing curricula, guiding the development of new blockchain programs, and ultimately addressing the knowledge gap within enterprises. Therefore, in the following sections, we discuss the scientific background of enterprise blockchain projects and the specific needs for respective learning courses. We then present our methodology, findings, and implications of our investigation into academic blockchain programs. Through this research, we strive to contribute to the development of a well-informed and blockchain-savvy workforce, enabling enterprises to seize the opportunities presented by this technology.

2. SCIENTIFIC BACKGROUND

Blockchain technology, with its inherent characteristics, is not just a tool; it's a cross-functional force that necessitates the involvement and collaboration of various key areas within an enterprise. Its integration goes beyond singular departmental efforts, making it a technology with high strategic impact and organizational scope. Figure 1 illustrates enterprise functions involved in the integration and operation of blockchain solutions (Düdder et al., 2021).

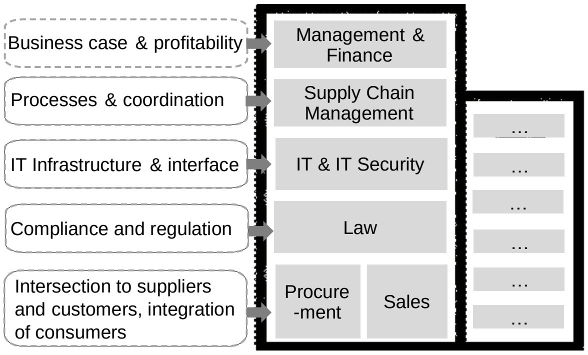


Figure 1: Enterprise Functions Involved in Blockchain Integration Projects

In the area of management and finance, blockchain demands a comprehensive business case and offers adaptations to existing ones. While integration costs are high, the technology shows potentials in both information flows (data storage, increased transparency, reduced costs for data exchange) and financial flows (faster, cheaper, and automated transactions) (Pennekamp et al., 2024). For these reasons, business implications and potential returns must be thoroughly analyzed to justify an investment in the technology (Al Kemyani, Al Raisi, Al Kindi, A. R. T., Al Mughairi, & & Tiwari, 2022; Sinha, Kumkum, & Bathla, 2019).

Supply chain management becomes a pivotal focus for blockchain integration, as the material flows between companies are transformed (Stammes, Burov, Ludwig, & Gürpinar, 2022). From tracking and tracing of goods to supply chain visibility, blockchains impact trust relationships and improve process efficiency (Grosse, Gürpinar, & Henke, 2021). The decentralized nature of blockchain facilitates real-time updates, reducing delays and enhancing the overall agility of cross-company processes (Queiroz, Telles, & Bonilla, 2019). Ultimately, blockchains afford the ability to reduce the need for intermediaries and therefore requires advanced governance concepts (Cole, Stevenson, & Aitken, 2019; Schwarzer et al., 2022).

In the IT domain, blockchain integration not only affects the existing system infrastructures but also reinforces security measures (Düdder et al., 2021). The decentralized and tamper-resistant nature of blockchains demand robust cybersecurity protocols to protect sensitive data (Iqbal & Matulevičius, 2019). IT departments play a critical role in ensuring the seamless incorporation of blockchains without compromising the organization's overall digital security (Düdder et al., 2019).

In the law sector, compliance and regulation functions can be insured. Blockchains enable full traceability and auditability of information (Roy, 2023). Additionally, they improve regulatory transparency with real-time transaction visibility. This is particularly apparent in the multi stakeholder use of blockchain in tax compliance (Adelekan et al., 2024; Bons, Keitzl, Schulz, Stuckmann-Blumenstein, & Gürpinar, 2023). Finally, also procurement and sales functions find intersections with blockchain integration and operation as suppliers and customers need to be involved. Here, blockchain-based smart contracts automate and streamline procurement processes while sales benefit from verifiable product and origin information (Gürpinar, Brüggenolte, Meyer, Ioannidis, & Henke, 2020).

The collaborative nature of blockchain integration underscores its complexity, as it requires coordination across multiple functions, each contributing its unique discipline and expertise. Successful integration and operation of blockchain solutions necessitates a holistic approach that considers interdisciplinary cooperation and management between the beforementioned and further functions and areas of an enterprise.

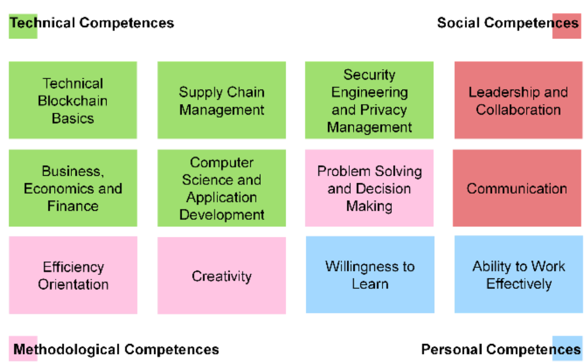


Figure 2: Competences to Integrate, Manage, and Operate Blockchain Solutions

Achieving successful integration and utilization of blockchain solutions within enterprises demands a multifaceted skill set that extends beyond technical expertise. While technical competencies are undeniably crucial, a holistic approach is essential, involving social, methodological, and personal competences as depicted in Figure 2. Social competences include effective leadership and communication, fostering collaboration, and ensuring that diverse teams work cohesively towards blockchain integration goals. Methodological competences, such as creativity and problem-solving abilities, are indispensable for navigating the complexities of blockchain solutions, addressing unforeseen challenges, and optimizing the technology's functionalities to suit the unique needs of an enterprise. Additionally, personal competences, like the willingness to learn and adaptability, are necessary in an ever-evolving technological landscape. The successful integration of blockchain technology depends on building a team with a mixed skillset combining technical expertise with social, methodological, and personal skills (Düdder et al., 2021; Fomin et al., 2024).

3. RESEARCH METHODOLOGY

To begin, in March 2024, a search was conducted on the AACSB website for US-based universities with AACSB accredited business schools with undergraduate, masters, and/or doctoral programs. This resulted in 533 universities. The term "blockchain" was then searched for on websites and catalogs of these universities. Out of this list, 151 were found to have at least one course pertaining to blockchain. This accounts for approx. 28% of the total AACSB business schools. Data such as the course key facts (offering department, number of courses, course level) and descriptions were collected from the schools' catalog and materials available on their websites and analyzed according to our evaluation scheme:

- Classification of Courses: Categorizing each course based on content and subject matter.
- Field Analysis: Determining the scientific field to which each course belongs.
- Technology Analysis: Identifying the interconnections between blockchain and other emerging technologies covered.
- Reconciliation and Peer Review: Ensuring the accuracy and consistency of the categorization through independent review and discussion among authors.

Classification of Course Topics

Each of the courses needed to be classified into one of the categories pertaining to blockchain. However, the categories first needed to be determined. The authors began by reviewing the course descriptions of the identified 361 blockchain courses. A set of categories was created based on this initial review. After the data was collected, the courses were mapped to this list of categories, similar to a process followed by Yang & Wen (2017) where they surveyed university IS program curricula found on their websites. Multiple authors independently reviewed the course descriptions and determined which category each course mapped to. If a course did not match any existing category, a new category was created, and all authors were notified of the new category. The next step was to reconcile the independently categorized lists. In cases where different categories were selected, the authors discussed and decided on the final categorization through peer debriefings following a consensual qualitative research approach.

Scientific Field and Technology Analysis

In addition to categorizing courses, the scientific fields to which these blockchain courses primarily belong were determined. The analysis involved examining the offering department titles and course descriptions to ascertain the primary field they were associated with. This classification helps in understanding the interdisciplinary nature of blockchain education as lots of courses have multidisciplinary approaches.

The interplay of blockchain with other emerging technologies was another critical area of analysis. Courses were reviewed to identify content covering the intersection of blockchain and artificial intelligence (AI), internet of things (IoT), and cybersecurity. This was achieved by carefully selecting synonyms and searching the course descriptions for references to these technologies. Understanding these connections provides insights into how blockchain is being positioned within the broader technological landscape and its relevance as an enabler of innovation.

4. FINDINGS AND DISCUSSION

Various university departments are providing blockchain courses as listed in Table 1. While Computer Science and Information Systems departments host the majority of the blockchain courses, individual courses are also offered by more uncommon departments such as Biology, Literature, and Political Science. A more detailed overview of departments and an allocation to respective scientific fields is shown in Appendix A.

The number of blockchain courses offered by universities varies. Most schools (381) do not offer any blockchain courses (Figure 3). However, 151 schools offer at least one; 76 at least two; and two schools offer a portfolio of at least 10 blockchain courses (Figure 3).

Department	Count
Computer Science	70
Information Systems	67
Finance	46
Business & Strategy	34
Law	31
General Management	14
Technology Management	11
Accounting	10
FinTech	8
Mechanical & Electr. Engineering	7
Comp. Science and Engineering	7
Supply Chain Management	7
Math, Statistics, and Insurance	6
Economics	6
Business Analytics	5
Cyber Security	4
Public Administration	3
Data Science	3
Entrepreneurship	3
International Business	2
Other	17

Table 1: Departments Offering Blockchain Courses

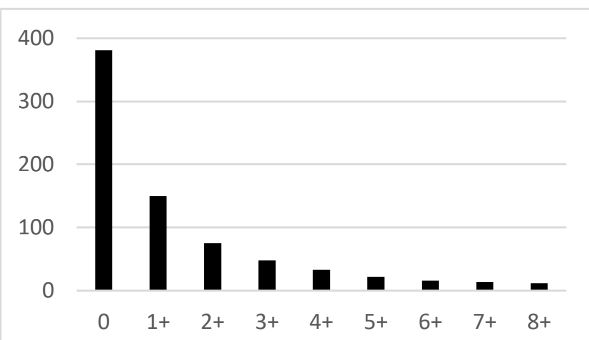


Figure 3: University's Number of Blockchain Courses

The majority (72%) of the blockchain courses being offered are at the undergraduate level; 23% at the graduate level; and 5% can be taken at both the graduate and undergraduate levels.

A greater total number of public universities offer blockchain courses (89 Public vs 62 Private, see Table 2). However, in looking within the university types, a greater percentage of the private universities offer blockchain courses. 36% of the private universities offer at least one blockchain course. Whereas only 24% of the public universities offer blockchain courses.

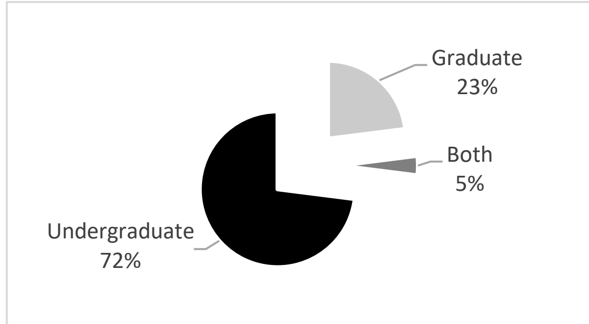


Figure 4: Academic Level of the Offered Blockchain Courses

	Count	Total	Percentage
Private	62	172	36.1%
Public	89	366	24.3%

Table 2: Universities Offering Blockchain Courses

In general, universities that have a larger undergraduate population offer at least one blockchain course. Universities with 25,001 to 30,000 students show 56% offering at least one blockchain course. Those with 30,001 to 35,000 students have 63.2% offering at least one course. Ultimately, all the schools reviewed with an undergraduate size of 40,001 to 50,000 offer at least one blockchain course (Table 3).

University Size	Count	Total	Percentage
0 - 5,000	30	169	17.8%
5,001 - 10,000	36	148	23.6%
10,001 - 15,000	18	71	25.4%
15,001 - 20,000	19	46	41.3%
20,001 - 25,000	11	34	32.4%
25,001 - 30,000	14	25	56.0%
30,001 - 35,000	12	19	63.2%
35,001 - 40,000	3	9	33.3%
40,001 - 45,000	2	2	100.0%
45,001 - 50,000	2	2	100.0%
>50,001	2	3	66.7%

Table 3: Number of Undergraduate Students

Appendix A provides a diagram showing the number of blockchain offerings by scientific field and university department. The largest area offering blockchain courses is Business with 216 courses overall. Within this area, Information Systems (67) as well as Finance and FinTech (54) have the greatest number of courses being offered. These two fields make up 56% of the total area course offerings. The second largest field with 85 courses is Computer Science including subcategories such as Cybersecurity and Data Science, along with the majority of courses (70) dedicated to general computer science, constituting 82% of the total area course offerings. Law makes up the third largest field with 31 offerings comprising of Law & Compliance departments. Arts & Sciences as well as Engineering are close to one another with their number of courses at 14 and 15, respectively. Eight courses in Math, Statistics, and Insurance departments made up 57% of the offerings in Arts & Sciences. Mechanical & Electrical Engineering (7) and Computational Engineering (7) department offerings made up 93% of the Engineering area offerings.

Category Name	**Courses in Category**
Fundamentals & Overview	140
Digital Assets & Cryptocurrencies	71
Technical Development	66
Business Implications	33
Law and Compliance	29
Supply Chain and Governance	12
Interplay with other Technologies	6
Other	4
Grand Total	**361**

Table 4: Blockchain Course Categories

To categorize the courses, we reviewed the data collected from each university and identified distinct thematic areas based on the content and focus of the courses. Table 4 shows the categories and the number of courses which were identified in these categories. The largest category of courses with 140 identified was the Fundamentals & Overview category. Digital Assets & Cryptocurrencies as well as Technical Development categories follow that with 71 and 66 courses identified in those categories, respectively. The next grouping of categories is those that focus on Business Implications (33) as well as Laws and Regulations (29). The final two categories are the ones on Supply Chain and Governance, which dropped to 12 and Interplay with Other Technologies with six courses identified in this category.

In addition to these findings, the review of the courses also reveals a focus on how emerging technologies interrelate with blockchain, either by enhancing its functionalities or by relying on them as foundational support and trust anchor. Appendix B provides a chart showing the different types of emerging technology trends which were discussed within the Blockchain courses. AI & Machine Learning was mentioned by the most blockchain courses (30). This was followed by Internet of Things (18) and Non-Fungible Tokens (15). Finally, Appendix C provides exemplary course descriptions of current blockchain courses showing how necessary competences and meaningful synonyms are covered, including the quantitative analysis of how frequently the requested competences appear across these courses.

5. CONCLUSION

This study explores blockchain course offerings in AACSB universities in the US. After assessing 533 universities, it was found that 151 of them offer at least one blockchain course, with a higher likelihood of such courses being offered in universities with larger undergraduate populations. While there are varying course topics, the majority deal with fundamentals of blockchain solutions and their basic functionalities. Additionally, a significant number of courses cover topics related to digital assets and cryptocurrencies. The largest percentage of course offerings occurs in computer science departments, with information systems and finance following. The interdisciplinary nature of blockchain technology is demonstrated by also having exceptional domains, such as biology, literature, and political science represented.

According to our findings, blockchain education is increasingly interconnected with other relevant emerging topics, such as artificial intelligence and digital twins. This integration underscores the necessity for students to understand the interconnected nature of modern technological ecosystems. It is also demonstrated that more than just technical skills are required; social, methodological, and personal competences are also relevant and addressed in many courses. This holistic approach to competency development is crucial to ensure that students are well-equipped in a multifaceted landscape of emerging technologies.

Future research should aim to further evaluate the topics covered in blockchain courses, as well as industry needs. It would be valuable to determine which disciplines are addressing each competency and how that aligns with industry demands. Researchers should look at job level competency needs and determine how they reconcile with the blockchain competencies. Research should also replicate this study in five years to assess any changes in course offerings. This will not only be valuable for blockchain research but will also help illustrate how topics evolve over time in any discipline.

6. REFERENCES

Adelekan, O. A., Adisa, O., Ilugbusi, B. S., Obi, O. C., Awonuga, K. F., Asuzu, O. F., & Ndubuisi, N. L. (2024). Evolving Tax Compliance in the Digital Era: A Comparative Analysis of Ai-Driven Models and Blockchain Technology in u.s. Tax Administration. *Computer Science & IT Research Journal*, *5*(2), 311–335. https://doi.org/10.51594/csitrj.v5i2.759

Al Kemyani, M. K., Al Raisi, J., Al Kindi, A. R. T., Al Mughairi, I. Y., & & Tiwari, C. K. (2022). Blockchain applications in accounting and finance: qualitative Evidence from the banking sector. *Journal of Research in Business and Management*, *10*(4), 28–39.

Bons, D., Keitzl, P., Schulz, H., Stuckmann-Blumenstein, P., & Gürpinar, T. (2023). A Taxonomy for the Formation of Enterprise Blockchain Consortia. *Blockchain & Cryprocurreny*, *1*(1).

Cole, R., Stevenson, M., & Aitken, J. (2019). Blockchain technology: implications for operations and supply chain management. *Supply Chain Management: An International Journal*, *24*(4), 469–483. https://doi.org/10.1108/SCM-09-2018-0309

Düdder, B., Fomin, V., Gürpinar, T., Henke, M., Ioannidis, P. A., Janaviciene, V., et al. (2019). BlockNet Report: Exploring the Blockchain Skills Concept and Best Practice Use Cases. *BlockNet Report.* Advance online publication. https://doi.org/10.48550/arXiv.2102.04333

Düdder, B., Fomin, V., Gürpinar, T., Henke, M., Iqbal, M., Janavičienė, V., . . . Wu, H. (2021). Interdisciplinary Blockchain Education: Utilizing Blockchain Technology From Various Perspectives. *Frontiers in Blockchain*, *3*(1). https://doi.org/10.3389/fbloc.2020.578022

Fomin, V., Gürpinar, T., & Baleviciene, D. (2024). Design of an interdisciplinary competence model for educational programs on blockchain technology. *Information & Media*, *99*, 41–62. https://doi.org/10.15388/Im.2024.99.3

Grosse, N., Gürpinar, T., & Henke, M. (2021). Blockchain-Enabled Trust in Intercompany Networks Applying the Agency Theory. In *ACM Digital Library, 2021 3rd Blockchain and Internet of Things Conference* (pp. 8–14). New York,NY,United States: Association for Computing Machinery. https://doi.org/10.1145/3475992.3475994

Grünewald, A., Gürpinar, T., & Culotta, C. (2024). Archetypes of blockchain-based business models in enterprise networks. *Information Systems and E-Business Management.* Advance online publication. https://doi.org/10.1007/s10257-024-00673-3

Gürpinar, T., Brüggenolte, M., Meyer, D., Ioannidis, P. A., & Henke, M. (2020). Blockchain Technology in Procurement - A Systematic Literature Mapping. *Konferenzband Zum Scientific Track Der Blockchain Autumn School 2020*, *1*, 7–13. https://doi.org/10.48446/opus-11859

Gürpinar, T., Henke, M., & Ashraf, R. (2024). Integrating blockchain technology in supply chain management - a process model with evidence from current implementation projects. *Hawaii International Conference on System Sciences*, *57*.

Iqbal, M., & Matulevičius, R. (2019). *Blockchain-Based Application Security Risks: A Systematic Literature Review*. Retrieved from http://arxiv.org/pdf/1912.09556 https://doi.org/10.1007/978-3-030-20948-3_16

Malik, S., Chadhar, M., Chetty, M., & Vatanasakdakul, S. (2022). Adoption of Blockchain Technology: Exploring the Factors Affecting Organizational Decision. *Human Behavior and Emerging Technologies*, *2022*, 1–14. https://doi.org/10.1155/2022/7320526

Pennekamp, J., Matzutt, R., Klinkmüller, C., Bader, L., Serror, M., Wagner, E., . . .

Wehrle, K. (2024). An Interdisciplinary Survey on Information Flows in Supply Chains. *ACM Computing Surveys*, *56*(2), 1–38. https://doi.org/10.1145/3606693

Queiroz, M. M., Telles, R., & Bonilla, S. H. (2019). Blockchain and supply chain management integration: a systematic review of the literature. *Supply Chain Management: An International Journal*, *25*(2), 241–254. https://doi.org/10.1108/SCM-03-2018-0143

Roy, S. (2023). The Impact of Blockchain Technology on Financial Regulations and Legal Frameworks. *SSRN Electronic Journal.* Advance online publication. https://doi.org/10.2139/ssrn.4521762

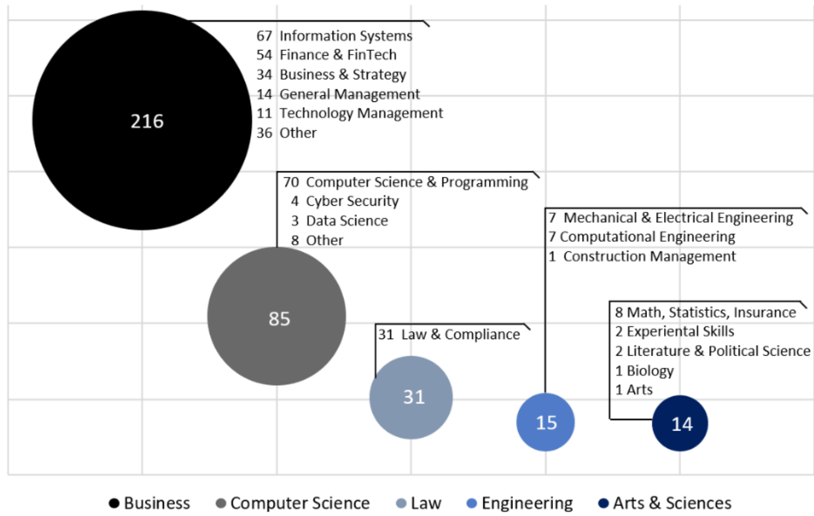
Schwarzer, M., Gürpinar, T., & Henke, M. (2022). To join or not to join? - A framework for the evaluation of enterprise blockchain consortia. *Frontiers in Blockchain*, *5*(1). https://doi.org/10.3389/fbloc.2022.935346

Sinha, S., Kumkum, & Bathla, R. (2019). Implementation of Blockchain in Financial Sector to Improve Scalability. In *2019 4th International Conference on Information Systems and Computer Networks (ISCON)* (pp. 144–148). Piscataway, NJ: IEEE. https://doi.org/10.1109/ISCON47742.2019.9036241

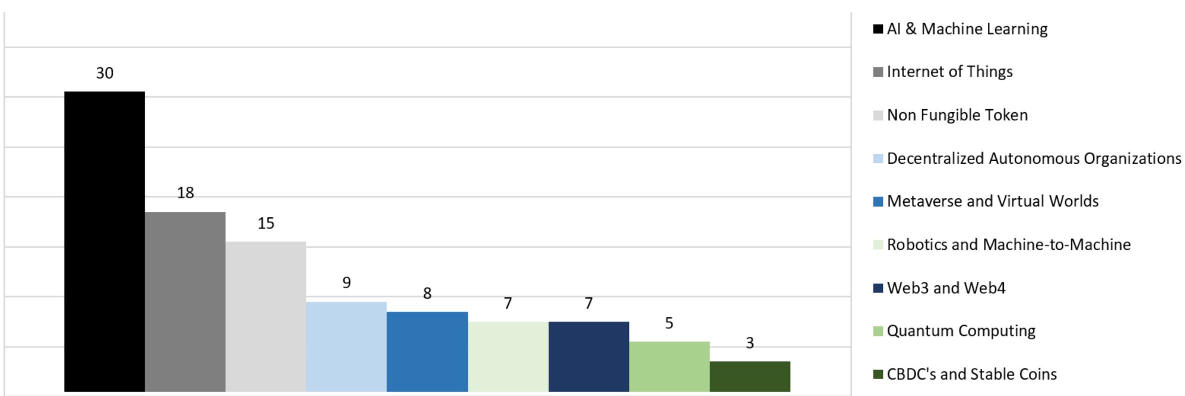
Stammes, R., Burov, E., Ludwig, T., & Gürpinar, T. (2022). *Strategic realignment of medium-sized companies due to distributed ledger technologies in supply chain management*. Hochschule Mittweida. https://doi.org/10.48446/OPUS-13457

Yang, S. C., & Wen, B. (2017). Toward a cybersecurity curriculum model for undergraduate business schools: A survey of AACSB-accredited institutions in the United States. *Journal of Education for Business*, *92*(1), 1–8. https://doi.org/10.1080/08832323.2016.1261790

Appendix A. Number of Blockchain Courses by Scientific Field and Department



Appendix B. Mentions of Emerging Technology Trends Considered in Blockchain Courses



Appendix C. Course Examples Addressing Relevant Blockchain Skills

Technical Competences

Technical BC Basics (228)
"Topics include blockchain fundamentals: what it is and what it can do, as well as the value proposition to different stakeholders." [1]

Supply Chain Mngmt. (30)
"The course teaches the importance of creating a secure end-to-end supply chain infrastructure and the use of blockchain-enabled smart contracts." [2]

Business and Finance (185)
"Course topics include the overall concepts and use cases to understand the potential business value and integration hurdles of blockchain technologies." [5]

Appl. Development (91)
"The course discusses DApp development using programming in Solidity language to illustrate smart contracts with Remix and Truffle environments." [6]

Security Engineering (75)
"Consensus mechanism design and its security, privacy enhancement for blockchain applications and performance improvements" [7]

Social Competences

Communication (6)
"The course contains principles and practices of how to provide secure communication between computer systems." [3]

Leadership Collaboration (15)
"Students will build practical knowledge of block-chain business applications and enhance management and leadership skills" [4]

Methodological Competences

Efficiency Orientation (5)
"The course demon-strates how the blockchain technology is applied in different business areas to improve efficiency and effect-tiveeness of operations." [9]

Creativity and Research (19)
"Students discuss the laws, theoretical justifications, and suggest new and creative reforms." [10]

Problem Solving (16)
"A course to understand blockchain technology and its applications to solve real life problems in various domains." [11]

Personal Competences

Willingness to Learn (2)
"The course requires a willingness to read and reread and discuss technical documentation and literature that is essential." [8]

Work effectively (13)
"This course equips business managers to effectively, identify, recognize, and evaluate key risks to business information systems." [12]

[1] American University - School of Business - "Blockchain Applications"
[2] California State University - College of Business & Public Administration - "Supply Chain Security and Blockchain"
[3] University of Connecticut - College of Engineering - "Network Security"
[4] Pepperdine University - Business School - "Emerging Technologies and Blockchain Security"
[5] Saint Louis University - School of Business - "Blockchain Technologies"
[6] University of Buffalo - School of Engineering and Applied Sciences - "Introduction to Blockchain"
[7] University of Tulsa - School of Computer Sciences - "Blockchain FinTech"
[8] Wake Forest University - School of Business - "Blockchain and Crypto Assets"
[9] Purdue University - School of Business - "Blockchain Technology For Business Applications"
[10] Fordham University - School of Business - "Blockchain Technology"
[11] Boise State University - College of Engineering - "Introduction to Blockchain"
[12] Cornell University - College of Business - "Introduction to Digital Technology/Transitions"

Exploring VR-Enhanced Learning in Business Education: A Multi-Site Study

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Abstract

Virtual Reality has the potential to transform educational experiences. This evolution, from the earliest days of projecting and viewing stereoscopic static images to the immersive headset experiences possible today, allows VR to transport students to new locations, enable them to participate in virtual spaces and simulations, and design 3-D objects, all of which might not otherwise be possible in the physical world. Echoing the World Economic Forum's claim about VR reshaping education, this paper examines initiatives and implementations of VR at three different business-oriented universities. The authors explore learning scenarios that VR can enhance, share experiences when creating engaging learning experiences using VR, and describe challenges faced when implementing and deploying VR at their schools. By highlighting applications of VR in higher education, the paper shows how interacting with VR can enhance learning and enable students to develop digital skills with immersive technologies.

Keywords: Virtual Reality, Emerging Technology, Instructional Technology, Deployment, Immersive Learning

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Exploring VR-Enhanced Learning in Business Education: A Multi-Site Study

Kevin Mentzer, Mark Frydenberg and Suhong Li

1. INTRODUCTION

In 1870, the Magic Lantern, or stereopticon, created new opportunities for teaching and learning, as this early version of the slide projector allowed educators to show images from around the world in their classrooms for the first time. The stereoscope of the late 19th century and early 20th century joined separate left-eye and right-eye images so its wearers could see them as a single three-dimensional image. Originally intended as an educational device for adults, the View-Master™ introduced in 1939 at the New York World's Fair, quickly became a popular children's toy, as it enabled high quality color photographic images to be viewed in stereoscopic reality for the first time. Fast forward to today and we are now considering how to integrate virtual reality (VR) in the classroom. Instead of seeing still images of a far-off land, students can now place themselves in a completely immersive environment, where they can explore the Pyramids of Egypt, design gathering spaces to meet up with friends or colleagues from around the world, design and visualize three-dimensional objects, and engage in conversations with virtual avatars who never run out of patience, in ways that were unimaginable just a generation ago. VR has the potential to revolutionize education by creating new environments where learners can interact not only with the world around them, but also in worlds that would otherwise not exist (Bekele et al., 2018; Dunmoye et al., 2024; Fabris et al., 2019).

According to the World Economic Forum, VR will reshape the future of education (The Future of Education Is in Experiential Learning and VR, 2022). Accordingly, colleges and universities are evaluating how VR can be integrated into the curriculum, not only for technology courses but across departments. Oftentimes faculty within the technology-based department are tasked to evaluate tools used throughout the university. This paper describes the VR initiatives undertaken at three higher education institutions.

Figure 1. Conceptual image showing a classroom using Virtual Reality (VR). Image generated with assistance of AI.

2. LITERATURE REVIEW

This paper refers to virtual reality (VR) as a technology most often experience by viewing completely computer-generated immersive images in a specialized headset; augmented reality (AR) as viewing digital content such as text or holograms superimposed on the real world, and extended reality (XR) as an umbrella term that combines these and potentially other immersive technologies. Figures 1 and 2 illustrate these concepts.

The *iLRN State of XR Outlook Report* (Lee et al., 2021) presents needs and opportunities, barriers, technologies, and developments for implementing immersive learning scenarios across the educational spectrum. This study explores three major questions as inspired by the iLRN report:

- How can immersive technologies enhance learning needs and take advantage of new prospects for learning?
- What are the major obstacles that institutions face when considering how to adopt immersive technologies?
- Which supporting tools and digital technologies could change how

instructors teach and have an impact on how students learn?

Figure 2. Conceptual image showing the use of eXtended Reality (XR) in an urban environment. Image generated with assistance of AI.

VR Opportunities
The convergence of generative artificial intelligence (AI) with XR technologies whereby AI driven avatars can participate in a virtual environment, will also create new opportunities for individualized instruction and learning across disciplines and industries. Generative AI can enrich VR experiences by providing intelligent and more human-like interactions (Chamola et al., 2023).

Immersive learning environments can provide authentic learning experiences for students through activities such as virtual field trips, simulations, meetings, and opportunities for collaboration (Juliana et al., 2022; Pirker & Dengel, 2021). While VR shows a promise as a pedagogical tool, additional research is needed to better understand its effectiveness and best practices for integrating it into the educational experience (Hamilton et al., 2021).

VR field trips transport learners to visit cultural or business locations that students could otherwise not experience in person to get a sense of "being there." VR simulations enable humans, represented as avatars, to participate in simulations of real-life scenarios, such as interview preparation, effective speaking, healthcare or customer experience. Meeting in common virtual spaces allows for participants in different physical locations to gather for a synchronous experience, as an alternative to Zoom. Virtual meeting spaces often have ambient sound for a more realistic experience, offer breakout rooms, and other collaborative features to create a virtual community among participants. Designing customized avatars can increase a sese of presence and promote successful group interactions in networked VR meeting spaces (Han et al., 2022).

Offering immersive learning at a business university exposes students to new technologies that they may see in their future digital workplace, enhancing their employability. VR applications also enable collaborators in separate locations to analyze the same dataset and build visualizations together seamlessly and in real time. Many business schools are already using VR to deliver executive education, for cross-cultural communication, and virtual conferences. College Cliffs provides several examples of how colleges are using VR for education. (Weems, 2023).

3. DISCUSSION

Faculty members at three different universities who implemented a diverse set of learning activities involving VR were asked to reflect on their experience with the goal of sharing lessons learned with other universities considering a VR initiative. Respondents were given a set of prompts to consider in writing up their reflections (see Appendix A).

A common theme at all three institutions is the selection and configuration of mobile device management (MDM) software. MDM is essential when implementing a large-scale deployment of headsets, as it allows administrators to install and update applications remotely on each device at the same time, control the content that users can interact with, and monitor the usage and status of each device in the collection, as shown in Figure 3. Meta provides MDM software for managing its Quest brand of headsets, while third-party solutions also exist which often support devices from multiple vendors and have different features. Fees are usually based on the number of devices being deployed annually. In addition to pricing models, administrators should consider ease of use, critical features needed such as whether or not you need to track student usage at the headset level or the application level, compatibility with current devices and those likely to be purchased in the future, and scalability, when selecting an MDM solution.

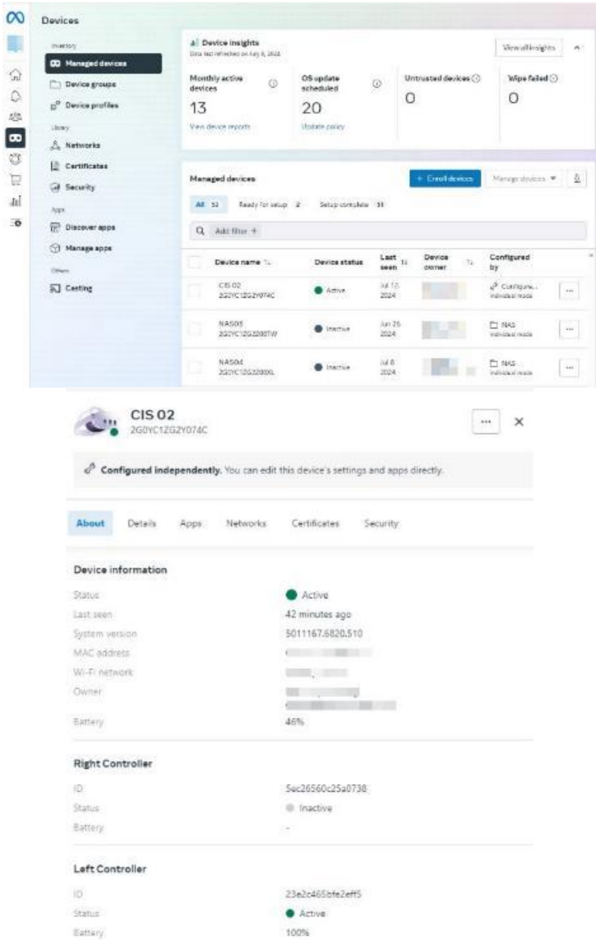

Figure 3. Mobile Device Management Software.

A second common theme was the creation of a dedicated physical space where students can gather to participate in VR activities. Repurposing existing classrooms is often common. Factors to consider when creating a dedicated VR lab space include:

- the size of the room, to ensure that VR headset-wearers have ample space to move around without bumping into anyone or anything.
- wireless Internet connectivity, with ample bandwidth to provide a smooth user experience
- ample and secure storage space and power strips to charge headsets when not in use.
- Procedures or cleaning and sanitizing headsets between use
- large displays to project headset content for those not wearing headsets to see
- create procedures for students to sign out headsets for home use
- A dedicated staff to manage the VR lab

Figure 4 shows Bentley University's VR classroom with equally spaced seating and large monitors on the walls for displaying a headset image so onlookers can participate. Students were wearing Quest 3 headsets and viewing the marine biology videos described in Case C below.

Case	Institution	Setting	VR Applications	Findings
A	Nichols College	First-Year Effective Speaking Course	• VirtualSpeech (public speaking)	Positive student feedback, increased engagement
B	Bryant University	VR Lab used in many disciplines	• Google Earth (earth visualization) • Ovation VR (public speaking) • Virtualitics (3D Data Visualization) • YouTubeVR (immersive video) • Various Games	Staffing and training challenges, increased student interest
C	Bentley University	Metaverse Course, Marine Biology, Career Readiness and "Soft Skills" Training	• FrameVR (immersive space designer) • Instructor-created Marine Biology Immersive Videos • BodySwaps (Soft Skills)	Positive student experiences, Hands-on learning, opportunities for student leadership

Table 1: Summary of VR in Business Education Cases

Figure 4. A VR Classroom.

Case Studies
Table 1 summarizes the general settings, VR applications used, and findings of VR implementations at three universities. Details of each case study follow.

Case A – Nichols College
Nichols College is an AACSB business school in the northeast U.S. primarily serving an undergraduate population of approximately 1200 students. Nichols College began exploring VR as a teaching tool in the fall of 2022. The institution received a Department of Education grant (Grant #P116Z230123) that included funding for hardware purchase, software licenses, and funds for faculty to integrate VR into their curriculum. The funding began in the Fall of 2023 and is designed to cover all 3 years of our pilot project.

Headset Evaluation. We spent close to one year evaluating and selecting the headset along with the Mobile Device Management (MDM) tool. The headsets and MDM tools were evaluated by a team that included faculty and IT. Our initial plan was to create a tethered headset lab with 12-16 nodes. However, in evaluating the various software tools we were convinced that the power of the untethered headsets would be adequate for our needs which would a) reduce the cost allowing us to expand to having 150 devices instead of 12-16, b) save on retrofitting a dedicated classroom to handle the tethered headset pods, and c) potentially achieve greater adoption since students would be able to use them in their homes or dorms. In the end we decided on 150 headsets including a mix of Meta Quest 2 and Meta Quest 3 untethered headsets and the Meta for Business MDM tool. While there were other MDM tools we evaluated that were cheaper, having the MDM tool by the same vendor as the headsets (Meta) ensured that support would be centralized and there were less risks of the headsets having issues with the MDM tool.

Headset Deployment. Our acquisition primarily consisted of Meta Quest 2 headsets. However, we also procured several of the more advanced Meta Quest 3 headsets to support potential augmented reality applications. We found the Meta Quest 2 headsets to be quite a bit cheaper in price than competing headsets from other vendors and realized we could purchase twice as many of these headsets over the competing products. While we budgeted for extended batteries and higher end head straps, we decided to hold off the decision of purchasing these until after our pilot. The only additional items we purchased were bags designed to hold the headset and controllers and additional AA batteries to have on hand for the controllers (while the headset is rechargeable, the controllers are not unless you replace the batteries with rechargeable batteries). We gave each headset a unique name in Meta for Business and used a labeler to label the headset and controllers which ensured that headset being returned matched the ones deployed.

Students were loaned a headset and carrying case to be used for the six weeks of the pilot. They signed a contract stating that they were responsible for reimbursing the cost of the headsets if they were not returned. We stressed to the students when we handed out the headsets that since the headsets were enrolled in the Meta for Business assigned to the university, the headsets would be unusable if we were to shut them down which we could do through the MDM tool.

With Meta for Business, applications that are certified by Meta are easily deployed without having to install the software manually on each headset. This caused us to switch vendors for the public speaking tool, as the one we initially identified was not certified while VirtualSpeech was certified. Had we selected the first option, we would have had to install the application on each headset individually. This might be manageable on a small number of headsets but does not scale for larger deployments. The MDM also supports uninstalling applications from all registered devices.

Project Plan Going Forward. Our project plan is to pilot VR in a new course each year across the three years of the project. We selected the tool VirtualSpeech (https://virtualspeech.com/) which we piloted for the first year in a course titled Effective Speaking. Figure 5 shows a virtual boardroom environment where users can practice public speaking, overlayed with analysis of a user's scores on various dimensions related to their speaking simulation.

Figure 5. VirtualSpeech

Effective Speaking is a core course required of all first-year students. While we usually offer approximately 8 sections of Effective Speaking each semester, the pilot was done in one section so we could evaluate how things went before scaling to all sections. The section selected had 24 students and was taught by the course coordinator who was enthusiastic about the technology but had no prior experience with VR.

Each student was provided with a Meta Quest 2 headset halfway through the semester to use for the rest of the semester. We did not install any other applications on the headsets, but students had access to the factory-installed applications. Students were able to install applications from the Meta Store if they chose to do so. We adopted this approach hoping that without restrictions on their use, students would be encouraged to explore their capabilities and overcome any preconceived challenges such as experiencing motion sickness when using their headsets. If students were comfortable using the headsets, that might increase overall usage of the VirtualSpeech application. While VirtualSpeech has embedded learning paths and lessons, we did not make any of them mandatory for the pilot. Instead, we were interested in learning if students would complete the lessons simply to help their own performance, or if they would explore the application further on their own. We surveyed the students at both the beginning and end of the pilot to gather feedback.

Results. Overall, the students' reaction was extremely positive. A sample of the positive responses include:

- "I found it to be helpful to get my words straight for my speech."
- "Felt like it helped me feel more comfortable in front of real people."
- "It helped in many ways and gave me many different outlooks on different speeches."

There was hesitation by a few students to use the headsets based on comfort of the headsets or the challenge of wearing the headsets with certain hair styles.

Only a few students completed the prewritten lessons provided in VirtualSpeech; most used the open virtual audience feature to practice their public speaking skills. A few students admitted that they did not use VirtualSpeech at all. The instructor felt that introducing the VR component to the course was helpful and encouraged its use in all sections in future semesters. We intend to integrate the supplied lessons from VirtualSpeech into the syllabus so they can act as assignments throughout the semester.

Most students also said that they used the VR headset for other activities, the most popular being watching YouTube videos. The consensus with the responses was that the use of the headsets was fun. While cases of students experiencing nausea and motion sickness were reported in other studies, none of our students claimed to have any issues with either.

Case B – Bryant University

Background. Bryant University is a private AACSB university located in the northeast U.S. The university offers a blend of business, liberal arts, and health sciences education and serves more than 3,500 undergraduate and graduate students. The university opened a VR Lab in 2019 with a grant of equipment from HP as part of the Educause-HP Campus of the Future initiative (Figure 6). The lab at that time was equipped with five HP Z-series graphic stations, a large digital display, several 360-degree cameras and 15 HP headsets. The initial headsets donated by HP were tethered devices, and subsequent research led to the purchase of 7 Oculus Rift headsets (which were also tethered). See Figure 6.

In 2023, the university library secured a grant to upgrade the technology with 20 Meta Quest 2 (untethered) headsets. The transition from tethered to untethered headsets was driven by the need for mobility and ease of use, although tethered headsets remain valuable for certain high-powered applications like Google Earth VR which will not run on some untethered headsets, due to the intensive graphics processing that they require.

Figure 6. A tethered VR headset is connected to a high-powered workstation.

Software Selection. The introduction of VR at the university was driven by a collaborative effort involving various stakeholders. The Center for Teaching Excellence, Information Services, and the Director of Academic Computing, and Lab Technology played pivotal roles in selecting and managing the VR equipment. Several applications were available on the headsets in the VR lab. See Table 1 above.

These tools offer a wide range of experiences, from educational simulations to narrative and historical content. A few faculty were consulted on the selection of VR software. We used the Arbor XR MDM tool to manage the applications on our headsets. Some of these applications are free and pre-installed while others have licensing fees.

Virtualitics offers advanced capabilities to enhance data analysis and visualization through immersive technologies. It supports 3D visualization and allows users to create complex, multidimensional visualizations that are more intuitive and easier to interpret than traditional charts and graphs (Figure 7). Users can interact with data through a VR headset, providing an immersive experience that enhances understanding and collaboration. Multiple users can interact with the same data set simultaneously, regardless of their physical location, which is useful for teams working remotely.

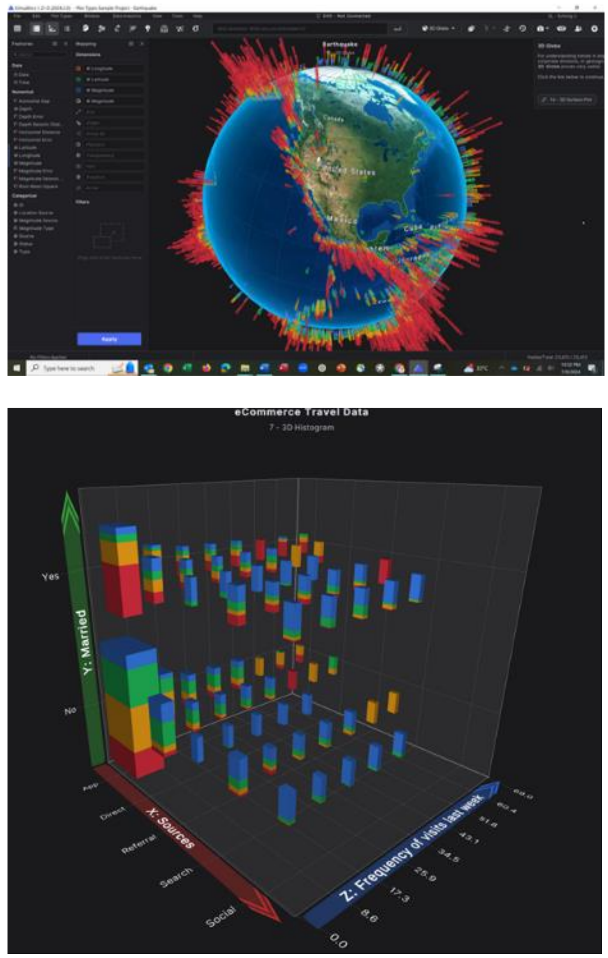

Figure 7. Virtualitics Visualizations.

Deployment. The deployment of the VR equipment was primarily handled by the Academic Computing and Lab Technology team, with some initial support from the Center for Teaching Excellence. This team was responsible for setting up the VR lab, including the installation of a data wall, a large interactive digital display that presents data in an interactive or engaging way, with the help of outside contractors. The support structure evolved over time, with the library taking over some responsibilities from the Center for Teaching Excellence in 2021. Currently, the library and Academic Computing team collaboratively manage the hardware and software, ensuring the VR lab's functionality.

To manage the VR headsets, the library employs a mobile device management (MDM) tool using a library-owned cell phone. This approach ensures that the headsets are well-maintained, and updates are efficiently managed.

Results. Several challenges emerged during the deployment and ongoing use of VR technology.

Staffing was a significant issue, as there were no dedicated personnel to manage the VR lab. Staff members from other departments, already burdened with full-time responsibilities, had to take on additional roles to support the VR space. This issue was partially mitigated in the Spring 2024 semester with the introduction of student staff to support open hours in the VR lab. Knowledge and training presented another challenge. The staff responsible for supporting and training others on VR usage had to learn the technology independently. This self-taught approach, while effective, highlighted the need for more structured training programs.

Faculty are encouraged to incorporate VR applications into their teaching/research. A few workshops are offered by the vendors and staff from libraries to train faculty on the use of VR applications. Some faculty also self-taught themselves. Several courses (data visualization, text mining, and data science capstone) that covers data visualization have brought students to the VR lab to use Virtualitics. Students in other communication and biology courses use VR applications including Ovation VR and Google Earth.

The lab has open hours that allow students to walk-in to experience VR and/or work on their research project. In addition, the VR lab has been used as a showcase to potential students/parents during open house or corporate partners during their visit. It has been incorporated into the data science summer camp for high school students. However, the lab has a limited capacity of 15 students since it only has five workstations with each station having 3 VR headsets. This restriction hampers the lab's widespread use. For larger classes, instructors must split students into two batches.

While many students initially had no prior experience with VR, interest and engagement have grown over time. The VR lab's open experimental hours have become a valuable resource for students to explore and familiarize themselves with the technology. Students enjoyed using various applications and playing games. However, some students and faculty have reported feeling uncomfortable or experiencing nausea after wearing VR headsets for extended periods.

The university is preparing to expand its VR capabilities. While the current lab will continue to serve the entire campus, a new data visualization classroom will be established in the new College of Business building, for dedicated use by data visualization courses.

Case C – Bentley University

At Bentley University, a business-focused university in New England, we share several examples of the use of virtual reality and for business education.

Living in the Metaverse. In Fall 2022, we introduced an experimental course, living in the metaverse, focused on the business technology and social impacts of the metaverse at a time when Meta (formerly known as Facebook) had just rebranded and VR technologies were becoming accessible. (Frydenberg et al., 2024) In the context of a first-year discovery seminar, “Living in the Metaverse” integrated standardized college-readiness topics with hands-on activities with collaborative assignments and class discussions to present a multidisciplinary exploration of the metaverse from business, technology, and societal perspectives. Students explored existing metaverse environments such as Decentraland, participated in virtual communities, and explored VR hardware and applications. In addition to readings from trade and research publications, the course culminated in students applying metaverse design principles to create their own immersive meeting spaces using the FrameVR platform that reflected elements of popular culture such as the hospital lobby below from the popular Gray’s Anatomy TV series. (See Figure 8.) The scenes that students created were of topics of their own interest; from a business education perspective, the key aspect of this assignment was to explore a software tool to build an immersive environment and apply best practices when doing so.

Lessons learned from the course included that hands-on activities with virtual reality headsets helped make metaverse concepts easier to grasp, and that students still had concerns about widespread use of the metaverse, including privacy and security.

Implementation. At the time this course was offered, our university had only four Quest 2 headsets available, so students needed to sign up in a computing lab to reserve time to use them. Tutors trained in using the headsets assisted the students, for many of whom, this was their first academic use of VR. We found that hands on experience with VR made learning about the metaverse much more tangible, and as the course evolved for a second and third offering, assigned students to have hands-on VR experiences early in the semester.

Figure 8. Living in the Metaverse scene.

Deploying VR with Bodyswaps. As participants in the Meta University Program (Clegg, 2023), our university explored the use of the Bodyswaps applications for developing practical life skills such as interview training or conflict resolution.

The VR applications we used to introduce VR technology to our campus were developed by Bodyswaps, a UK company. Participants tried modules on topics from preparing for job interviews and public speaking to diversity and inclusion and having difficult conversations. By completing these modules, students explored essential skills: learn how others see them; develop self-awareness; practice self-introductions; build confidence talking to new people; practice communicating ideas clearly and with confidence; and prepare for job interviews. One of the main benefits of the Bodyswaps application is the feedback provided to the user on their performance of each module. Users and their avatars "swap" places so that the user can then see how they reacted or performed. See Figure 9.

This was a multi-step endeavor led entirely by student technologists employed in the university's CIS Sandbox technology lab. Upon receiving the VR headsets, they managed the entire project and developed a project plan as shown below. The group facilitated training sessions for more than 150 students, faculty, and staff in a two-week period to introduce them to immersive education through the Bodyswaps training and simulation modules. As a result of this successful initiative, the following semester, the university's first-year student discovery seminar course piloted the use of the Bodyswaps modules across several sections.

Figure 9. Student participating in a Bodyswaps training.

Among the lessons learned, first and foremost, an MDM (mobile-device-management) application is essential for managing a network of VR headsets. One feature we would like to see is the ability to select a headset in use and automatically cast, or display, its content on a remote screen on demand. This capability enables lab assistants helping participants with their headsets to see exactly what the participants are seeing in their headsets, allowing them to give more detailed support or instructions. Often, lab assistants had to ask users if they saw a particular screen or icon to help troubleshoot their situations. In extreme cases, the assistants would have to trade places with the users, temporarily putting on their headsets so they could help navigate the situation. Also, the ability to cast any headset display to a screen would allow instructors to check in on student progress and allow users to share their experiences with the rest of the class in the context of a VR demonstration.

Having a dedicated space for using and storing the VR headsets is quite helpful. Our campus did not have such a space at first, and that meant distributing each headset and pair of controllers in an empty meeting or conference room, calibrating the "guardian zone" around each user and setting the height of the floor. Even with a dedicated VR classroom, which we later set up at our university, it takes about 5 minutes per headset to turn on and test prior to using the device.

Student tutors assisting the participants monitored how users in Bodyswaps reacted and interacted with the headsets and the applications, and they actively sought feedback. Students using the Bodyswaps modules were mostly pleased with the experience, which differed from their expectations or previous encounters with VR, which were mostly for gaming.

In addition to leading the training, students learned the steps involved in deploying a VR installation. Tasks included setting up the headsets, configuring the device management software, teaching other tutor facilitators how to use the learning modules, and scheduling and facilitating learning sessions. One tutor commented, "Although we used the Bodyswaps modules in our testing, we weren't only evaluating the program itself. Rather, we considered our sessions as proof of concept for VR applications in learning-based environments."

Exploring Underwater Ecosystems. Stoner (2024) developed virtual reality experiences designed to immerse learners enrolled in a natural science course to explore diverse marine environments. Providing hands-on learning activities "helps students engage more deeply and meaningfully with the course material than they ever could with a textbook." Using VR to explore these ecosystems addresses issues of equity as all students now have access to these undersea explorations that might not otherwise be available to them (Figure 10). ((Under) Sea Change, 2024) See Coastal Marine Ecosystem Experience (https://www.eco-mem.com/) for more information.

Figure 10. Exploring Ecosystems in VR.

This virtual experience in marine biology led to both increased student engagement and knowledge retention when compared to traditional classroom settings. Students felt more immersed and connected to the material, leading to better understanding and a desire for further learning. While not implemented in a business context, this marine biology scenario also introduces students to how VR technology can improve learning and provides an experience that they can take to their future workplaces.

4. DISCUSSION

The discussion thus far has focused on current projects that provide a variety of individual opportunities for integrating immersive education in the information systems curriculum. This section presents a next step in immersive education and describes two proposed university programs that extend VR opportunities beyond the undergraduate student population.

From Individual to Collaborative VR

Most of the examples discussed in this paper enable individual learning activities using VR tools. Students wear a headset, use an app, and have their own individual experience: they explore locations virtually, participate in simulated experiences with avatars, or complete trainings and simulations. Participants have similar experiences, but individually. They then return to the "real world" to take off their headsets and debrief about their virtual journeys: how "real" they looked, how intuitive it was to navigate in the virtual world they visited, how VR added to create an experience that might otherwise not be possible.

A trend that is gaining traction in the world of immersive education is collaborative VR, where participants interact simultaneously with each other in shared virtual spaces. Collaborative VR can mitigate the sense of isolation by allowing participants to maintain a sense of connection with their physical surroundings. A user wearing a VR headset might sit at their physical desk but see a virtual conference room where they join other participants, and their avatars have a seat at the table.

In these collaborative immersive environments, technology takes a secondary role and enables opportunities that were previously not possible. Users can create their own virtual spaces or objects by importing assets and using drag-and-drop configuration. Table 2 summarizes features of some collaborative immersive web-based platforms. All provide access via VR headsets as well as web-based through a browser.

Platform	Description
FrameVR	Users can create and join virtual spaces for collaboration, education, and events.
HorizonWorlds	Meta's platform for interacting in 3D worlds, supporting social interactions, games, meetings, and events.
ShapesXR	A collaborative design tool for creating 3D models and iterating on designs.
ZoeImmersive	A platform for creating and sharing interactive 3D experiences and building immersive lessons.

Table 2. Collaborative VR Tools

Extending Beyond Undergraduate Education
The increased use of immersive technologies is transforming learning experiences not only for undergraduate students, but opportunities are extending to elementary school through graduate school programs at our institutions.

Nichols College is piloting a program with a local middle-school to use VR technologies to help students learn about language and culture. Using VR, students will be immersed in a foreign language while visiting locations around the world in the target language.

At Bentley University, a professional MBA workshop is planned to introduce graduate students to immersive technologies, as they are rapidly emerging as critical tools for businesses seeking innovative ways to engage with customers, drive digital commerce, and manage operations. This hands-on lab will introduce students to the business opportunities and challenges associated with immersive technologies, focusing on their applications in strategic leadership and innovation.

Students will explore the technological foundations of immersive experiences, including XR (extended reality), virtual reality (VR), augmented reality (AR), and mixed reality (MR), while examining case studies of successful business integrations. The lab will culminate in the specification of a VR-enabled business strategy project, allowing students to apply the concepts they have learned in a practical setting.

Integrating immersive technologies as a teaching tool to learn about subject matter as well as about business and technology applications represents a shift in educational processes. Collaborative VR tools will create new opportunities for learning from a distance. As these technologies become more widespread, they promise to transform education at all levels, making learning more effective and inclusive.

5. CONCLUSIONS

Overall, we found students excited about using VR technology in new ways. While some faculty first had concerns about nausea or dizziness, students reporting discomfort were rare. We found that starting students with activities that they enjoyed (such as exploring YouTube videos) helped them quickly overcome motion sickness.

Successful configuration and deployment of VR headsets often requires institutional technological support and infrastructure. These steps serve as a guide for managing and deploying a VR installation.

- Unbox and label headsets and controllers.
- Configure headsets on MDM software
- Set up apps for use on headsets
- Test and learn the apps to be deployed
- Train facilitators who will support users in the VR lab or with the headset activities
- Lead or assist at sessions with users

Careful coordination and the identification of division of responsibilities is critical for successful deployment. Faculty members must ensure that VR applications align with course goals and learning objectives. They can help promote the use of VR at their institutions by being role models for their colleagues who may be resistant to adopting new technologies for learning. By involving faculty throughout the process institutions can ensure that VR is integrated effectively into the learning environment.

Institutions have three primary options for deploying VR:

- Tethered (i.e. wired) headsets in a lab environment requiring not only the headset but also a PC to operate the headset
- Untethered headsets in a lab potentially reducing the risk for damage or loss but requiring a lab space
- Untethered headsets loaner program which are still under direct control through the MDM software

Table 2 summarizes advantages and

Factor	Advantages	Disadvantages
Location	A dedicated lab space provides control over environment and resources.	A dedicated lab space requires planning and managing a space, need to consider sound isolation and additional costs for PCs.
Headsets	Tethered headsets can support more graphics-intensive applications. Non-tethered headsets are less expensive, easy to set up, and have a variety of applications available.	Tethered headsets require both a headset and a PC. Non-tethered headsets could be more prone to theft.
Applications	Many applications are available on a variety of content/ topics.	Educators must be careful when selecting VR apps to ensure they meet learning goals and improve the learning experience for students.

Table 3. VR Deployment Considerations

disadvantages when considering factors involved in a VR deployment.

Overall, the authors found a good variety of VR applications spanning both business and arts and sciences. This allows IS faculty to collaborate with colleagues and departments that they might not otherwise do so.

With these deployment guidelines and an increasing number of engaging VR applications, institutions can create new learning spaces and experiences that encourage collaboration among colleagues and provide immersive learning opportunities in business education and across disciplines.

6. REFERENCES

Bekele, M. K., Pierdicca, R., Frontoni, E., Malinverni, E. S., & Gain, J. (2018). A Survey of Augmented, Virtual, and Mixed Reality for Cultural Heritage. *Journal on Computing and Cultural Heritage*, *11*(2), 1–36. https://doi.org/10.1145/3145534

Clegg, N. (2023, September 12). Metaverse Technologies Are Creating New Opportunities for Teachers to Inspire Students. *Meta*. https://about.fb.com/news/2023/09/metaverse-technologies-education-opportunities/

Chamola, V., Bansal, G., Das, T. K., Hassija, V., Sai, S., Wang, J., ... & Niyato, D. (2024). Beyond reality: The pivotal role of generative ai in the metaverse. *IEEE Internet of Things Magazine*, *7*(4), 126-135. https://doi.org/10.1109/IOTM.001.2300174

Dunmoye, I., Olaogun, O., Hunsu, N., May, D., & Baffour, R. (2024). Examining the Predictive Relationships Between Presences of a Community of Inquiry in a Desktop Virtual Reality (VR) Learning Environment. *IEEE Transactions on Education*, *67*(3), 343–350. https://doi.org/10.1109/TE.2023.3340101

Fabris, C. P., Rathner, J. A., Fong, A. Y., & Sevigny, C. P. (2019). Virtual Reality in Higher Education. *International Journal of Innovation in Science and Mathematics Education*, *27*(8). https://doi.org/10.30722/IJISME.27.08.006

Frydenberg, M., Yates, D., & Noonan, A. (2024). Teaching the Metaverse: Applying TPACK to a Multidisciplinary First Year Seminar Course Design. *ISEDJ*, *22*(5), 18. https://doi.org/10.62273/RXFI8909

Hamilton, D., McKechnie, J., Edgerton, E., & Wilson, C. (2021). Immersive virtual reality as a pedagogical tool in education: A systematic literature review of quantitative learning outcomes and experimental design. *Journal of Computers in Education*, *8*(1), 1–32. https://doi.org/10.1007/s40692-020-00169-2

Han, E., Miller, M. R., Ram, N., Nowak, K. L., & Bailenson, J. N. (2022). *Understanding Group Behavior in Virtual Reality: A Large-Scale, Longitudinal Study in the Metaverse* (SSRN Scholarly Paper 4110154). https://papers.ssrn.com/abstract=4110154

Juliana, A., Nurqamarani, A. S., Fadila, S., Rullinawati, R., & Aripin, S. (2022). Virtual Reality in Business Education: Systematic Literature Review. *Lembaran Ilmu Kependidikan Journal of Educational Research*, *51*(1), 21–32.

Lee, M.J.W., Georgieva, M., Alexander, B., Craig, E., & Richter, J. (2021). *State of XR & Immersive Learning Outlook Report 2021.* Walnut, CA: Immersive Learning Research Network

Pirker, J., & Dengel, A. (2021). The Potential of 360° Virtual Reality Videos and Real VR for

Education—A Literature Review. *IEEE Computer Graphics and Applications*, *41*(4), 76–89. IEEE Computer Graphics and Applications. https://doi.org/10.1109/MCG.2021.3067999

Stoner, Elizabeth. (2024, March). *Virtual seagrass: Using virtual reality as a tool to immerse learners in nearshore ecosystems*. Zozterapalooza National Seagrass Conference.

The future of education is in experiential learning and VR. (2022, May 23). World Economic Forum. https://www.weforum.org/agenda/2022/05/the-future-of-education-is-in-experiential-learning-and-vr/

(Under) Sea Change: Virtual Reality and Aquatic Exploration. (2024, June 12). https://www.bentley.edu/news/under-sea-change-virtual-reality-and-aquatic-exploration

Weems, L. (2023, December 28). *How Are Colleges Using Virtual Reality (VR) for Education: What It Means for Students*. College Cliffs. https://collegecliffs.com/virtual-reality-vr-for-education/

APPENDIX A

Respondent Instructions

Instructions: The purpose of this study is to explore how different colleges/universities deployed VR technology. I would expect 1-1½ pages per school. Focus on tips and tricks, lessons learned, etc. This paper is meant to help other organizations who might be considering adopting VR.

The topics below are meant to spur ideas about what worked/didn't work. You cannot really answer all of them in 1 ½ pages, but you should emphasize what you feel the most valuable insights you gained because of your rollout.

Background – tell us a bit about your college/university. Describe how VR is being used at your school.

Organization (role of IT vs Faculty vs ??)
- How did the process of **purchasing** your equipment occur? Who managed it? Was IT involved?
- How did the process of **deploying** your equipment occur?
- How did the process of **supporting** your equipment occur?
  a. What issues did you run into after deployment?

Training:
- How were faculty brought up to speed on the technology?
- How were students trained?

Headsets:
- What vendors/headsets did you consider?
- How did you decide between tethered and untethered headsets?

Mobile Device Management (MDM) Tools:
- Did you consider using an MDM tool for managing the VR headsets? Which ones?

Motivation:
- Why did you pursue VR in your organization?

Funding:
- How did you fund your acquisition?

Software Tools
- What tools did you consider?
- Which ones did you pilot?

Student Response:
- What were the student's responses to the technology?

Future:
- Where is your program headed?

Conclusions: Key lessons learning for any of the above? Advice for other institutions?

Assessing the Impact of Prerequisite Courses on Student Performance in Database Normalization

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Abstract

Continuing to fill the literature gap, this research replicated and expands a prior study of student performance in database normalization in an introductory database course. The data was collected from four different universities, each having different prerequisite courses for their database course. Student performance on a database normalization exam was compared between students who took the various studied prerequisite courses (CS1 procedural programming, CS2 object-oriented programming, and discrete mathematics) and those who did not. These comparisons were conducted using quantitative methods and produced non-significant results, different from those results of the prior study. With the current research design and sample size, the researchers are confident in their results that suggest these prerequisite courses do not impact student performance.

Keywords: database, normalization, programming, discrete math, pedagogy

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Assessing the Impact of Prerequisite Courses on Student Performance in Database Normalization

Kevin Slonka, Matthew North, Neelima Bhatnagar and Anthony Serapiglia

1. INTRODUCTION

One of the core concepts taught in introductory database courses is relational modeling. Despite its importance, students encountering this concept for the first time often struggle with both comprehension and application (Bunch, 2009). These challenges often stem from a lack of prior exposure to key concepts such as data normalization, cardinality, and keys. The abstract nature of relational databases further complicates the learning process for new students (Freyberg, 1996).

Common problems for students new to relational databases include difficulty in grasping the logical structure of data relationships, confusion over the syntax and semantics of coding languages such as Structured Query Language (SQL), and an inability to effectively translate real-world scenarios into database designs (Philip, 2007). Misunderstandings in foundational topics such as primary and foreign keys, normalization forms, and query optimization frequently lead to frustration and hinder academic progress. Further, students often struggle with the transition from conceptual design to implementation, a gap that is critical for practical proficiency in database management (Thompson & Sward, 2005).

Given this reality, it is reasonable to hypothesize that students with some background in computer programming logic and abstract thinking will realize higher levels of comprehension and achievement than database students who lack such background. This study tests that theory by testing one primary hypothesis constructed from the overarching research question, "What impact do prerequisite courses have on student performance in database normalization":

H_1: Procedural programming experience does not affect student scores on database normalization.

Additionally, this study added two additional hypotheses to analyze the remaining two possible prerequisite courses:

H_2: Object-oriented programming experience does not affect student scores on database normalization.

H_3: Discrete math experience does not affect student scores on database normalization.

This research will analyze and discuss the student, faculty, and organizational impact of these prerequisite courses.

2. REVIEW OF THE LITERATURE

The design of relational databases has been found to be a difficult concept for students to grasp (Thompson & Sward, 2005; Kung & Tung, 2006; Hingorani, Gittens, & Edwards, 2017). Further exacerbating the difficulty are the inconsistencies in notational styles for Entity-Relationship Diagrams (ERD), the most common technique for visualizing relational databases, such as Thompson & Sward's (2005) proposed approach. Beyond the issues with diagramming is one of the core tenants of relational design, the process of normalization.

Pedagogical research into mitigating challenges and enhancing the teaching and learning of relational database concepts, such as normalization, has been conducted for at least the past 25 years (Chan, Teo, & Zeng, 2005; Philip, 2007). Early efforts to improve student comprehension of relational database concepts often assumed that students needed foundational coursework in programming and abstract math in order to understand relational modeling (Chilton, McHaney, & Bongsug, 2006; Kung & Tung, 2006; Zhang, Kaschek, & Kinshuk, 2005). This is further worsened by the disagreement of whether third normal form (3NF) is satisfactory or if further forms should be taught (e.g., 4NF, BCNF, 5NF, DKNF, etc.) (Carpenter, 2008). However, work by Dominguez & Jaime (2010) and Enciso & Soler (2013) and others soon challenged this assumption by testing methods of teaching relational database concepts through contextualization and concept attainment. Much of the early research on teaching database design focused on the question: Must students understand programming and abstraction to successfully design relational databases?

Research into cognitive load theory began to inform the structuring of course content to avoid overwhelming students with complex information prematurely (Batra & Wishart, 2014; Bunch, 2009). Empirical studies over the past 15 years have analyzed student performance in database classes to identify effective strategies and relevant foundational knowledge, guiding the continuous improvement of educational practices (Katz, 2020; Mitrovic & Suraweera, 2016). One such strategy is providing visualizations and ensuring that students have plenty of opportunities to interact (Hamzah et al., 2019; Folorunso & Akinwale, 2010; Jaimez-Gonzoalez & Martinez-Samora, 2020). Tayal & Bura (2012) successfully tested a novel approach to teaching database normalization to novices through a concept attainment teaching method, finding that a plurality of students, regardless of prior coursework in computing or math, achieved at least a satisfactory level of comprehension of course content.

Sastry (2015) and, more recently, Sing et al. (2021) examined an innovative teaching method focused on problem-based learning to enhance students' understanding of core database design concepts. Their approach employed practical, hands-on problem-solving activities, rather than traditional lecture methods. By designing teaching examples and homework exercises that emphasized both critical thinking and technical skills, engaging students in real-world database design challenges, their research showed higher levels of student achievement as the learning process became more interactive. Wang & Wang (2023) found similar results by employing interactive NoSQL database instruction within business education. Their research tests the use of practical exercises and projects to help students understand concepts, data models, and query languages, resulting in improved student performance when compared to traditional teaching methods. This research background informs the experimental design in our study.

The noticeable lack of recent literature brings forward the gap this research fills.

3. METHODOLOGY

Five sections of a database management class, in which all students were computing majors, were studied. One section was taught at a regional campus of an R1 university in Western Pennsylvania. This course did not require any prerequisite programming courses or math courses. The second section was taught at a Western Pennsylvania Catholic university that requires a procedural programming course as a prerequisite, though some students also had taken an object-oriented programming course as well as a discrete mathematics course. The third section was taught at a different Western Pennsylvania Catholic college. This particular course had prerequisites of procedural programming, object-oriented programming, and discrete mathematics. The fourth and fifth sections were taught at the largest public university in a particular Western-US state. This university's database course also did not require any prerequisite courses in programming or mathematics. The sum of all participants in this study was n=136.

The researchers coordinated their content and grading, with all courses teaching the same concepts that culminated in an exam on normalization. All sections administered a standard exam and all grading was done with a standard rubric to ensure the integrity of the study. The exam was a raw data set in a Microsoft Excel file that asked the students to normalize the data into third normal form. The instructions given to students are shown in Appendix A.

In addition to collecting the grades of each student, the researchers also gathered data on whether or not each student had taken their university's CS1 (procedural programming), CS2 (object-oriented programming), and discrete mathematics course. The collection of this data and further analysis in SPSS allowed for the testing of this study's primary hypotheses:

H_1: Procedural programming experience does not affect student scores on database normalization.

H_2: Object-oriented programming experience does not affect student scores on database normalization.

H_3: Discrete math experience does not affect student scores on database normalization.

4. RESULTS

The demographics of the population are shown in Table 1 as well in Appendix B Figure 1. While the majority of the participants had taken the CS1 course, the numbers evened out with CS2 and discrete math due to those courses either not being a prerequisite of the database course or not being a required course in their major.

	n	%
Total	136	100.0
CS1		
Yes	115	84.6
No	21	15.4
CS2		
Yes	88	64.7
No	48	35.3
Discrete Math		
Yes	71	52.2
No	65	47.8

Table 1: Frequencies

The data was then checked for normality to determine the proper statistical analyses to run. When viewing the scores grouped by each prerequisite course it was apparent that the data was non-normal but could be argued to be either normal or non-normal, depending on whether one focused on the "yes" answers or the "no" answers, shown in Appendix B Figure 2 with the combined histograms and Q-Q plots. Focusing only on the empiric distribution, the normality discrepancy is apparent.

The empiric nature of the data's normality is backed up by the Skewness and Kurtosis values, which can also lead one to choose either parametric or non-parametric analyses due to some values being closer to 0 than others, shown in Table 2.

		Skewness	Kurtosis
CS1	Yes	-0.391	-0.904
	No	-0.117	-0.906
CS2	Yes	-0.412	-1.086
	No	-0.643	-0.493
Discrete Math	Yes	-0.333	-1.137
	No	-0.599	-0.181

Table 2: Skewness & Kurtosis for Normality Testing

Because of these inconsistencies, the researchers ran both the parametric and non-parametric tests. For each hypothesis the non-parametric test (Mann-Whitney U) will be presented followed by the parametric test (independent samples T-Test). Although the grouping variable only contains two groups (yes/no), the researchers also ran the stronger ANOVA test, which typically requires at least 3 groups, to be completely certain that their results were valid (Pallant, 2010).

H_1: Procedural programming experience does not affect student scores on database normalization.
Shown in Table 3, the non-parametric Mann-Whitney U test did not produce a significant result. When running the independent samples T-Test, the significance value was taken from the "Equal variances not assumed" portion of the test due to the significant Levene's Test for Equality of Variances. This test also did not produce a significant result. The stronger parametric test, the ANOVA, corroborated the previous two tests with a non-significant finding.

Test	Significance
Mann-Whitney U	0.818
T-Test	0.468
ANOVA	0.588

Table 3: Parametric & Non-Parametric Statistics for H_1

These results lead the researchers to accept the null hypothesis, suggesting that procedural programming experience does not affect student scores on database normalization.

H_2: Object-oriented programming experience does not affect student scores on database normalization.
Shown in Table 4, the non-parametric Mann-Whitney U test did not produce a significant result. When running the independent samples T-Test, the significance value was taken from the "Equal variances not assumed" portion of the test due to the significant Levene's Test for Equality of Variances. This test also did not produce a significant result. The stronger parametric test, the ANOVA, corroborated the previous two tests with a non-significant finding.

Test	Significance
Mann-Whitney U	0.321
T-Test	0.501
ANOVA	0.534

Table 4: Parametric & Non-Parametric Statistics for H_2

These results lead the researchers to accept the null hypothesis, suggesting that object-oriented programming experience does not affect student scores on database normalization.

H_3: Discrete math experience does not affect student scores on database normalization.
Shown in Table 5, the non-parametric Mann-Whitney U test did not produce a significant

result. When running the independent samples T-Test, the significance value was taken from the "Equal variances assumed" portion of the test due to the non-significant Levene's Test for Equality of Variances. This test also did not produce a significant result. The stronger parametric test, the ANOVA, corroborated the previous two tests with a non-significant finding.

Test	Significance
Mann-Whitney U	0.519
T-Test	0.590
ANOVA	0.590

Table 5: Parametric & Non-Parametric Statistics for H_3

These results lead the researchers to accept the null hypothesis, suggesting that discrete math experience does not affect student scores on database normalization.

5. DISCUSSION

This study was a more comprehensive replication of a prior study by Slonka & Bhatnagar (2024). The prior study was limited with a small sample size and the lack of a standardized exam and grading rubric. This study corrected those errors while also expanding the sample to more universities in more geographic areas. This allowed the results of this study to be more generalizable and more legitimate.

The prior study found that having prior experience with procedural programming led to lower normalization scores and having prior discrete math experience also led to lower normalization scores. These results were unsatisfactory due to the previously mentioned errors. This study corrects those missteps by suggesting that students' grades on normalization are not affected by any of the three prerequisite courses tested. This has multiple implications for computing majors that include a database course.

First, removing these prerequisites from the database course could lead to higher enrollments in the class sections. This would not only benefit faculty, ensuring their sections do not get canceled due to low enrollment, but also the university for obvious financial reasons.

Second, students could be able to take the database course earlier in their college career. Being able to take a database course in the first or second year of a major, instead of during the last two years, would allow computing departments to strengthen their data-focused curriculum, offering higher-level database courses as well as other courses that would typically require the database course as a prerequisite, such as data analytics or data warehousing.

Third, the removal of these prerequisites could remove the barrier preventing students outside of a university's computing majors from taking the database course. Databases play a role in many non-computing majors and having this course available for non-computing majors could result in the need for many more sections, which also translates to dollar signs. Lastly, it is possible that the simpler nature of SQL as a programming language could be a gateway for students to enroll in more intense computer science courses. This could greatly improve enrollment in computing majors but would need further research to determine legitimacy.

6. CONCLUSION

In investigating student comprehension of the relational database model, this study aimed to identify the impact of prior knowledge in programming concepts and discrete mathematics on learning outcomes. Our analysis reveals no statistically significant differences in comprehension levels between students with a background in these areas and those without. This finding suggests that familiarity with programming or discrete mathematics does not inherently translate to a better understanding of relational databases. The lack of a significant correlation suggests that while programming and mathematical skills are valuable, and are a core, indispensable component of college-level academic programs in the computing fields, they may not directly influence a student's ability to grasp the relational database model.

These findings underscore the necessity of developing specialized teaching methods tailored specifically to relational databases, rather than relying on students' prior knowledge in related fields. Emphasizing fundamental database concepts from the ground up, using practical examples, interactive learning tools, and active engagement techniques, may prove more effective in fostering comprehensive understanding. This study did not test the effectiveness of specific teaching methods or tools, only the effect of having taken programming or math classes before taking the introductory database course. We find that students should be encouraged to take their first database class early in their studies, whether they have already taken programming or discrete mathematics or not.

Another limitation, for which it would be difficult to control, is any exposure to database concepts the students received prior to their college career. Although the researchers' experience leads them to believe that these concepts are not found in any secondary school curriculum, it remains a possibility.

This study highlights the importance of faculty engaging in continuous pedagogical research to identify and implement teaching practices that directly address the unique challenges faced by students learning relational databases. Future research should explore a broad range of instructional techniques, including peer-assisted learning, real-world project-based assignments, and adaptive learning technologies, to enhance student comprehension and retention. Additionally, research into different visualization tools and other possible prerequisite courses could yield fruitful results.

7. REFERENCES

Batra, D., & Wishart, N. (2014). Novice designer performance comparison between the entity relationship event network and the event-based logical relational design techniques. *Journal of Database Management, 2*5(3), 1–27. https://doi.org/10.4018/jdm.2014070101

Bunch, J. M. (2009). An approach to reducing cognitive load in the teaching of introductory database concepts. *Journal of Information Systems Education, 20*(3), 269–275.

Carpenter, D. A. (2008). Clarifying normalization. *Journal of Information Systems Education, 19*(4), 379-382.

Chan, H. C., Teo, H. H., & Zeng, X. H. (2005). An evaluation of novice end-user computing performance: Data modeling, query writing, and comprehension. *Journal of the American Society for Information Science & Technology, 56*(8), 843–853. https://doi.org/10.1002/asi.20178

Chilton, M. A., McHaney, R., & Bongsug Chae. (2006). Data modeling education: The changing technology. *Journal of Information Systems Education, 17*(1), 17–20.

Domínguez, C., & Jaime, A. (2010). Database design learning: A project-based approach organized through a course management system. *Computers & Education, 55*(3), 1312–1320. https://doi.org/10.1016/j.compedu.2010.06.001

Enciso, M., & Soler, E. (2013). Teaching database design: A reverse engineering approach. 2013 IEEE Global Engineering Education Conference (EDUCON), *2013 IEEE*, 474–480. https://doi.org/10.1109/EduCon.2013.6530148

Folorunso, O. & Akinwale, A. (2010). Developing visualization support system for teaching/learning database normalization. *Campus-Wide Information Systems, 27*(1), 25-39. https://doi.org/10.1108/10650741011011264

Freyberg, C. A. (1996). Teaching independent novice learners to develop relational database applications. *Proceedings 1996 International Conference Software Engineering: Education and Practice, Software Engineering: Education and Practice*, 64–67. https://doi.org/10.1109/SEEP.1996.533982

Hamzah, M. L., Rukun, K., Fahmi, R., Purwati, A. A., Hamzah, H., & Zarnelly. (2019). A review of increasing teaching and learning database subjects in computer science. *Revista Espacios, 40*(26), 6-14.

Hingorani, K., Gittens, D., & Edwards, N. (2017). Reinforcing database concepts by using entity relationships diagrams (ERD) and normalization together for designing robust databases. *Issues in Information Systems, 18*(1), 148-155.

Jaimez-Gonzalez, C. R. & Martinez-Samora, J. (2020). DiagrammER: A web application to support the teaching-learning process of database courses through the creation of E-R diagrams. International *Journal of Emerging Technologies in Learning, 15*(19), 4-21. https://doi.org/10.3991/ijet.v15i19.14745

Katz, A. (2020). Improved teaching of database schema modeling by visualizing changes in levels of abstraction. *Journal of Information Systems Education, 31*(4), 294.

Kung, H. & Tung, H. (2006). An alternative approach to teaching database normalization: A simple algorithm and an interactive e-learning tool. *Journal of Information Systems Education, 17*(3), 315-325.

Mitrovic, A., & Suraweera, P. (2016). Teaching database design with constraint-based tutors.

International Journal of Artificial Intelligence in Education: Official Journal of the International AIED Society, 26(1), 448–456. https://doi.org/10.1007/s40593-015-0084-6

Pallant, J. (2010). SPSS survival manual. McGraw Hill.

Philip, G. C. (2007). Teaching database modeling and design: Areas of confusion and helpful hints. *Journal of Information Technology Education, 6*, 481–497. https://doi.org/10.28945/228

Sastry, K. S. (2015). An effective approach for teaching database course. International *Journal of Learning, Teaching, and Educational Research, 12*(1), 53-63.

Singh, A., Bhadauria, V., & Gurung, A. (2021). A problem-solving-based teaching approach to database design. *Journal of Emerging Technologies in Accounting, 18*(2), 149–155. https://doi.org/10.2308/JETA-19-10-13-41

Slonka, K. J. & Bhatnagar, N. (2024). Teaching database normalization: Do prerequisites matter? *Issues in Information Systems, 25*(1), 128-135. https://doi.org/10.48009/1_iis_2024_111

Tayal, D., & Bura, D. (2012). An efficient approach for identifying functional dependencies in a database class. *IUP Journal of Information Technology, 8*(1), 36–47.

Thompson, C. B., & Sward, K. (2005). Modeling and teaching techniques for conceptual and logical relational database design. *Journal of Medical Systems, 29*(5), 513–525. https://doi.org/10.1007/s10916-005-6108-3

Wang, H., & Wang, S. (2023). Teaching NoSQL databases in a database course for business students. *Journal of Information Systems Education, 34*(1), 32.

Zhang, L., Kaschek, R., & Kinshuk. (2005). Developing a knowledge management support system for teaching database normalization. *Fifth IEEE International Conference on Advanced Learning Technologies (ICALT'05), Advanced Learning Technologies*, 344–348. https://doi.org/10.1109/ICALT.2005.117

APPENDIX A

Normalization Exam (100 pts)

Using the exam-data.xlsx file, create a normalized database (3rd normal form).

Considerations:

- There are 5 main entities within this data, but you will need 7 to properly design the database.
- Students enroll in course sections, not courses.
- Students should be allowed to enroll in multiple course sections.
- Surrogate keys are allowed and are, in most cases, preferred. You must decide whether the data already contains a proper primary key or you need to create a surrogate or composite key.

Upload the following item to complete this exam:

1. ERD (PDF or image file)
    a. Diagram must use correct Crow’s Foot notation. An online tool, such as Lucid Chart, is sufficient for this.

APPENDIX B

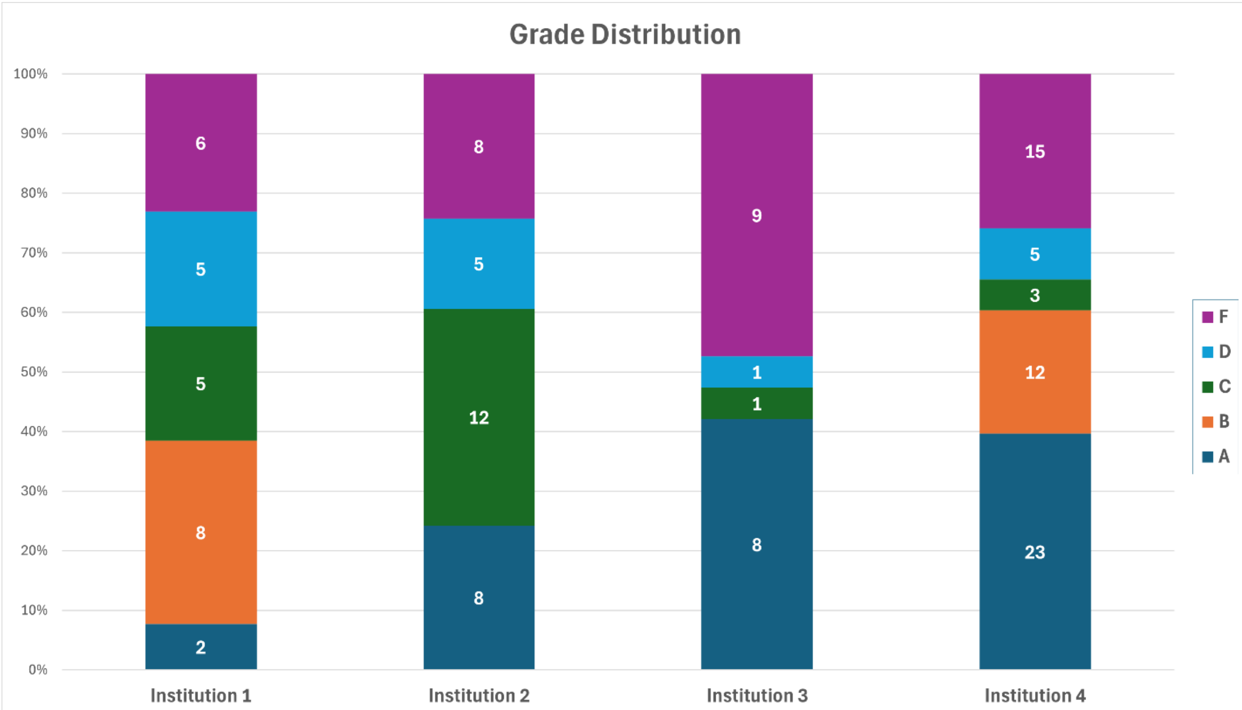

Figure 1: Grade Distribution by Institution

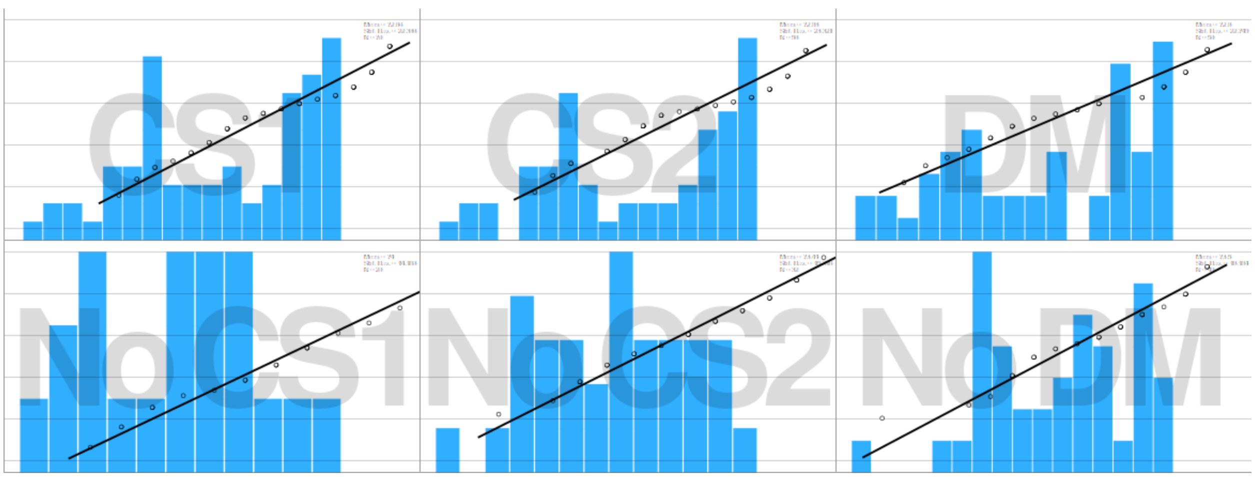

Figure 2: Histograms and Q-Q Plots

Teaching Case

Countering the "Plagiarism Slot Machine": Protecting Creators and Businesses from AI Copyright Infringement

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In 2022, Artist Kelly McKernan began seeing her dreamy, sci-fi style of creative images online, but there was a big problem—it wasn't her work. McKernan discovered that people around the world were using the prompt "in the style of Kelly McKernan" and generating images through AI platforms such as Midjourney and Stable Diffusion. So, in January 2023, McKernan joined artists Sarah Andersen and Karla Ortiz in filing a copyright infringement lawsuit against these AI generative program developers claiming that the companies infringed the rights of millions of artists. The complaint alleges that these AI platforms scraped five billion images from the web during the training of their systems and are using these copyrighted materials without the consent of the original artists. How can computer scientists and programmers contribute to finding a solution to this increasingly complex problem?

Abstract

The rapid rise of AI use is creating some very serious legal and ethical issues such as bias, discrimination, inequity, privacy violations, and—as creators everywhere fear—theft of protected intellectual property. Because AI platforms "learn" by scraping training materials available online or what is provided to them through their human programmers, these systems can easily capture copyrighted expressions, such as song lyrics, computer code, stories, or images, and use them to generate new works without attribution. This rise in AI use of protected material is spawning an array of legal actions as artists, programmers, writers, photographers and other creative individuals witness the erosion of their value in the marketplace and the world. As students prepare to enter the field, they need to be aware of legal issues and concerns that they may face and methods for addressing them. This case focuses on the problem of AI copyright infringement of art and includes an exploratory exercise that introduces students to the act of "scraping"—a primary AI training method by which copyrighted works may be vulnerable to potential infringement.

Keywords: Teaching Case, Screen Scraping, Data Pools, Metadata, AI Copyright Infringement, AI Training

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Countering the "Plagiarism Slot Machine": Protecting Creators and Businesses from AI Copyright Infringement

Christine Ladwig, Dana Schwieger and Reshmi Mitra

1. INTRODUCTION

The rapid advancements of generative artificial intelligence (AI) are impacting almost every aspect of life… even the art world. Creative artists are finding that they are competing not only with other artists for commissions, but also with generative AI programs trained on versions of their own work. Issues concerning generative AI training datasets continue to surface. Researchers in the Data Provenance Initiative evaluated 1,858 of the most popular open-source publicly available datasets used to train natural language processing models (e.g., GitHub, Hugging Face, Papers With Code, etc.). Through their audit, they found that over 70 percent of the datasets had no data licenses. For those that did have licenses, "roughly half were incorrect" and "29 percent of the incorrect licenses were more permissive than the dataset creators had intended" (Gent, 2023).

Copyright infringement lawsuits against tech companies are being filed and as organizations, such as *The Atlantic* magazine, make searchable databases of AI dataset resources available to artists, will continue to increase (Gent, 2023). Legislation for protecting creative works is in the process of being developed; however, this is a relatively new territory.

With these advancements in mind, students preparing for careers in industry need to be aware of and develop skills for addressing dataset concerns. This case introduces students to copyright concepts and issues associated with machine learning training datasets through the examination of current legal actions, responses by industry standard setting bodies to putting safeguards in place, and a hands-on exploratory exercise in which students scrape a site for images and examine their metadata.

2. PLAGIARISM SLOT MACHINE

Kelly McKernan is a very successful fantasy artist with famous clients including Horse Comics, Stranger Things, and ImagineFX. Within the last few years, another group of artists have been posing a challenge to McKernan's position in an already limited marketplace—AI generative programs such as Midjourney and Stable Diffusion. It was discovered that people around the world were using the prompt "in the style of Kelly McKernan" and generating images through these AI platforms. Over 11,000 images in McKernan's distinctive style were found on one platform server alone, and all were generated without the artist's consent or input (Chow, 2023).

Artists' Style Reproduced by Generative AI

McKernan noted that opportunities for creating art are disappearing as AI generative programs increase in use; for instance, prior to the rise in Midjourney/Stable Diffusion, McKernan was securing multiple commissions per month. But now, some of those opportunities are flowing to the AI generative programs: "It's…pretty wild to know that instead of hiring me (McKernan) for a book cover, someone can just go into a program, use my name to emulate something close enough and good enough, at a fraction of the price" (Chow, 2023). And the feeling of violation by artists is significant, according to McKernan "AI is not a tool, it's a plagiarism slot machine" (Dean, 2023).

McKernan and Other Artists File Lawsuit

In January 2023, Kelly McKernan joined artists Sarah Andersen and Karla Ortiz in filing a copyright infringement lawsuit against these AI generative programs claiming that companies such as Midjourney and Stable Diffusion infringed the rights of millions of artists. The complaint alleges that these AI platforms scraped five billion images from the web during the training of their systems and are using these copyrighted materials without the consent of the original artists. The suit also stated that, "These companies benefit commercially and profit richly from the use of copyrighted images…the harm to artists is not hypothetical, as generative AI art is already sold on the internet, siphoning commissions from the artists themselves." The original suit was filed in January 2023 and amended in November of the same year to add seven plaintiffs and one new defendant, Runway AI.

Tech Companies Sued
Artists are not the only creators that are feeling the sting of AI's dominance in their industry. On November 3, 2022, Microsoft Corporation and its computer code-sharing website GitHub, as well as artificial intelligence firm OpenAI, were sued in the U.S. District Court for the Northern District of California. The class-action complaint (J. DOE 1, et al., Plaintiffs, v. GITHUB, INC., et al., Defendants) claimed that the companies' AI-powered programming tool Copilot infringed copyright by using millions of lines of human-written code without proper attribution. According to reporters for NewScientist, this is the "first big copyright lawsuit over AI and potential damages could exceed $9 billion" (Wilkins, 2022).

Software Programmers' Work Violated
Around the same time that the action against Microsoft and Open AI was filed, internet chatter began to blanket the Web with similar claims of AI infringement against software coders, artists, writers, and other content creators. For instance, in October 2022, Texas A&M University Computer scientist Tim Davis claimed on Twitter (now X) that the Microsoft-owned AI programming assistant Copilot "emits large chunks of my copyrighted code, with no attribution, no LGPL license." (Davis, 2022) The "LGPL" Davis mentions is a type of Open-Source use permission—the Lesser General Public License—which makes the code available for use to anyone if they adhere to the license requirements, such as attribution (which identifies the copyright holder of the work being reused—in this case developer Davis). Davis laments the fact that not only is his copyright being reaped and infringed by commercial AI generative programs, but the copied code is also enclosed behind a paywall, defeating his intent to make it available for free (with attribution).

New York Times Files Lawsuit
In addition to artists and coders, there have been reports of widespread AI infringement of other content publishers including newspapers and journals. For example, at the end of 2023, The New York Times (*The Times*) joined the copyright infringement fray, also with an action against Microsoft and OpenAI, alleging that the Large Language Machines (LLMs) were copying and using millions of the newspaper's copyrighted articles.

The Times stated in its complaint that "Through Microsoft's Bing Chat (recently rebranded as "Copilot") and OpenAI's ChatGPT, Defendants seek to free ride on The Times' massive investment in its journalism by using it to build substitutive products without permission or payment." (The New York Times Company v. Microsoft Corporation (1:23-cv-11195), 2023). The complaint describes the infringing LLMs as containing copies of article content, which is then generated in prompt responses as text that "is verbatim, closely summarizes it [The Times' content], and mimics its expressive style." The Times submitted thousands of pages of exhibits demonstrating the alleged infringement, with entries dating back to the 1950s. The Times also pointed out the benefits of the AI developers' unauthorized use: a trillion dollar increase in Microsoft's market capitalization due to Copilot, and a $90 billion valuation for OpenAI's ChatGPT. (The New York Times Company v. Microsoft Corporation (1:23-cv-11195), 2023).

Clearly, AI generative programs are creating havoc through their training and operational actions, imperiling the livelihoods of creators all over the world. An engineer who spoke to author James Vincent of the *Verge* about AI copyright infringement shared this sobering sentiment: "If you take my attribution off, my career is over, and I can't support my family, I can't live." (Vincent, 2022).

Copyright vs. Trademark vs. Patent
While protecting Kelly McKernan's artwork and the stories written by New York Times' journalists is best accomplished by copyright, the latter is not the only form by which creators may safeguard their intellectual property assets. For example, inventions are typically protected through the use of the "patent", which is a grant from a government authority made in exchange for public disclosure. U.S. issued patent protection allows the inventor (or patent owner) to exclude others from using, making, or selling the invention for a limited time—usually around 20 years from the filing date of the patent application. Patent protection is most valuable for those creations that can easily be reverse engineered, as it allows the inventor to initially license or practice their invention without competition (ideally). Trademark is another protective measure intended for brand names, logos, slogans, and other identifiers that distinguish goods or services in the marketplace. The U.S. trademark can last indefinitely as long as it is renewed. There are intellectual property assets which have these multiple forms of protection attached—the smartphone, for instance. The software (operating system) and interface design of most phones are protected by copyright; the brand name, logo and design protected by trademark; and hardware components and touchscreen technology are

typically utility inventions safeguarded through issued patent(s). However, when considering the rights associated with creative works of art, the rules associated with copyright must be followed.

3. THE NATURE OF COPYRIGHT AND THE NATURE OF INFRINGERS

The U.S. Copyright Office cites 1790 as the year that Article I, Section 8 of the United States Constitution codified the belief that "authors of a work may reap the fruits of his or her intellectual creativity" through federal protection. Although limited in scope when initially approved by Congress—protecting only books, maps, and charts for a 14-year period—the Copyright Act of 1790 has evolved to modernly safeguard a wide breadth of original works of authorship, including "literary, dramatic, musical, architectural, cartographic, choreographic, pantomimic, pictorial, graphic, sculptural, and audiovisual creations." (U.S. Copyright Office, n.d.).

Copyright Law

Copyright law is intended to protect the works of "human" creators by granting the right to: "(1) reproduce the copyrighted work; (2) prepare derivative works based on the original; (3) distribute copies of the work; (4) perform the copyrighted work publicly; and (5) display the copyrighted work publicly" (Tyser, 2024). A work created solely by AI, according to the U.S. Copyright Office cannot be copyrighted (US Copyright Office, 2023). In AI infringement cases, the AI is trained by making a copy of the original work, possibly violating the creators' right to reproduce. Plaintiffs in these lawsuits have also alleged that any AI model is infringing due to containing compressed copies of the originals, and the generation of "new" images or works is a violation of the right to prepare derivative works.

Copyright Benefits

In granting a period through which artists, musicians, writers, and other creators can protect their works from theft, copyright laws provide not only the benefit of economic compensation for the copyright holder, but also rewards for the public as the works are created and disseminated. There is evidence that these benefits are significant for creators and distributing entities. In 2022, the International Intellectual Property Alliance (IIPA), an organization representing U.S. Copyright-based industries, reported that copyright-dependent companies added $1.8 trillion to the U.S. GDP (7.76% of the entire U.S. economy) and employed 9.6 million American workers in 2021 (Stoner & Dutra, 2022).

OpenAI's Perspective

Copyright protection is widely considered to be an appropriate and just reward for creators, providing attribution and compensation for their efforts. However, not all parties are aligning with the concept of compensating individuals such as artist Kelly McKernan for the value of their efforts. AI generative programs are indiscriminately scraping the internet and making copies of, and consuming, billions of copyrighted images, writings, and code without attribution or compensation to the creators. For instance, responding to a 2019 "Request for Comments on Intellectual Property Protection for Artificial Intelligence Innovation from the United States Patent and Trademark Office ("USPTO")", OpenAI, LP—inventor of the well-known AI generator ChatGPT argued that in order to "benefit all of humanity" and be "compelling to humans," machine learning must "analyze large corpora (which necessarily involves first making copies of the data to be analyzed)" by accessing millions of documents, photographs, images, text, and audio. The company suggests that the "use of entire works is reasonably necessary" to creating AI systems, and that because the training is done by a machine, and not a human, there is no lessening of the market or value of copyrighted works. (Chadwick, 2024).

ChatGPT also responded in December 2023, to an inquiry into LLMs by the U.K. House of Lords Communications and Digital Select Committee and stated: "Because copyright today covers virtually every sort of human expression–including blog posts, photographs, forum posts, scraps of software code, and government documents–it would be impossible to train today's leading AI models without using copyrighted materials." (HOL CDSC, 2023). The company also added that "Limiting training data to public domain books and drawings created more than a century ago might yield an interesting experiment but would not provide AI systems that meet the needs of today's citizens." (Chadwick, 2024).

The Copyright Alliance's Letter to Congress

In a December 2023 letter to the U.S. House of Representatives Subcommittee on Courts, Intellectual Property, and the Internet, Copyright Alliance (a not-for-profit copyright holder advocate) CEO Keith Kupferschmid emphasized that copyright infringement by AI platforms was significant and alarming, having "increased exponentially and grown in sophistication, causing widespread harm to the economic and creative vibrancy of the copyright community." (Kupferschmid, 2023). Kupferschmid explains that "A number of recently filed lawsuits allege that leading AI developers use datasets to train their AI models that contain unauthorized versions of hundreds of thousands of literary works, many of which are scraped from notorious "shadow library" piracy websites. While these and similar large-scale rogue websites have harmed copyright owners for years, the problem is compounded by AI developers that scrape and ingest the stolen copyrighted materials to "train" generative AI models" (Kupferschmid, 2023). Therefore, in addition to indiscriminately scraping the internet for easily accessible copyrighted materials, Kupferschmid suggests that AI platforms are also training on protected works from piratical websites. It is clear from the associations advocating for copyright holders, as well as the entities that benefit from copyrighted creations, that AI infringement is a serious issue that requires an expedient resolution.

4. AN IMMEDIATE SOLUTION

On May 8, 2024, California Federal Judge William Orrick gave a green light to creator Kelly McKernan's case against the AI generator companies. Orrick stated that the now *ten* artists (the case began with three) behind the lawsuit "had plausibly argued that Stability, Midjourney, DeviantArt, and Runway AI copied and stored their work on company servers and could be liable for using it without permission." (Brittan, 2024) Yet, as the case moves forward, the artists are still experiencing infringement as AI generative programs copy and incorporate digital images of their artwork and offer it to their own "creators/subscribers" protected behind a paywall. Users (including businesses) of generative AI are also nervous about the potential liability if creators are able to demonstrate infringement. Successful copyright cases have awarded billions of dollars in damages. The urgency of the situation is therefore dire as these lawsuits proceed through the courts and requires an immediate solution.

5. PROTECTION FOR CREATORS AND GENERATIVE AI DEVELOPERS

Under the just and necessary presumption that creators such as artist Kelly McKernan are entitled to copyright protection, as well as compensation and/or attribution for their creations, what then is the solution to protecting rights holders while concurrently creating a path for AI developers to legally use their works for AI training purposes? In order to protect these artists and provide some measure of control, as well as compensation and/or attribution, computer scientists and programmers are called upon to design generative AI training pools with a conscionable effort to respect the rights of the product creators. The question becomes, how is this done? The first step in avoiding copyright infringement is for programmers and image data pool designers to become familiar with classifying and identifying graphic image files through metadata.

6. IMAGE METADATA FAMILIARITY

There are many copyright infringement lawsuits currently working their way through the court system, and without a definitive ruling on whether AI generative programs are infringing creators' copyright, it is prudent for potential users of internet content to ensure that they are using materials that are copyright free. All graphic image files contain metadata, which is embedded information such as technical data, descriptive information, and copyright details. The International Press Telecommunication Council (IPTC) Photo Metadata specifications have been in use since 1995. Google has been using IPTC photo metadata fields since Autumn 2018 (IPTC, 2024c).

Metadata properties are grouped into Administrative, Descriptive and Rights-related properties. In response to AI data mining concerns raised by image rights owners, the IPTC, in close collaboration with the Picture Licensing Universal Systems (PLUS) Coalition, released a new version of their IPTC Photo Metadata Standard containing two new properties, Data Mining and Other Constraints on October 4th, 2023 (IPTC 2024b). Later that same month, IPTC announced that similar capabilities were added to their IPTC Video Metadata Hub version 1.5 (IPTC, 2024a).

Photo Metadata Properties

The IPTC Data Mining property contains a standard list of values that creators can use to indicate if the image can be used for AI or Machine Learning purposes. The prohibition can be set to "Prohibited except for search engine indexing" to "only permit[s] data mining by search engines to the public to identify the URL for an asset and its associated data (for the purpose of assisting the public in navigating to the URL for the asset), and prohibits all other uses, such as AI/ML training." (IPTC, 2024b) The User Note associated with the Data Mining property warns, "Similarly, the absence of a prohibition does not indicate that the asset owner grants permission for data mining or any other use of an asset." (IPTC, 2024b)

The IPTC Other Constraints property is a text-based property that was also added allowing creators to include finer detail in a human readable format (Quinn, 2023). Upon their release, the IPTC encouraged developers of graphic and video software tools, as well as generative AI crawling engines, to incorporate the new properties into their software (IPTC, 2024a). Thus, digital media creators can use these field properties to identify if their work is copyrighted and requires attribution or if the work can be used in a training data set. These properties can then be utilized by training pool creators to identify the type of attribution the media creator wishes to receive and whether or not to include the file in the pool.

Thus, with the ability to specifically associate the intentions of the creator with their works, programmers will need to incorporate processes and coding into their programs to abide by those intentions. Failure to incorporate such consideration may cause their works to infringe upon a work's copyright and place their employer at risk for possible lawsuit(s).

7. CONCLUSION

If the courts determine that the "copies" AI generative programs make during training are infringing copyright, generative AI program developers will need to be able to access training data pools of valid, usable data. Additionally, graphic data used by businesses should be copyright-free or licensed; users are not protected from copyright violations even if they are using a third-party AI generative program (both are considered to be infringing copyright). Therefore, as computer science students prepare to embark on careers that will most likely involve working with artificial intelligence, it is imperative that they are aware of, and consider, content creator rights and intentions for their works. As AI capabilities are being embedded in an increasing number of programs, faculty will need to broaden the scope and coverage of related content. To illustrate the underlying thoughts, concepts, and processes that should be considered when developing a generative AI training pool, the next two sections provide questions for discussion and an exercise that introduces students to the methods by which AI "scrapes" the internet to appropriate images.

8. QUESTIONS FOR DISCUSSION

This section can be used for case and concept discussion. After reading the case, answer the following questions.

1. What problems were artists, programmers, and content publishers (e.g., newspapers and journals) experiencing?
2. What is a copyright? Why is copyright—and not patent or trademark protection—the best protection for artwork?
3. What is the purpose of a copyright?
4. What does a copyright grant to the copyright holder?
5. What court cases were discussed in the case?
6. What logic have organizations such as OpenAI and Microsoft offered to support their use of copyrighted works?
7. What is image file metadata?
8. What metadata data mining properties are available?
9. What are some of the risks associated with training AI by scraping the internet?
10. One proposal to protect copyrighted works is to create dedicated training pools for AI. What do you think about this option?
11. Using a generative AI tool (ChatGPT, Microsoft Copilot, Google Gemini, etc.), find current court cases in which generative AI programs have infringed upon copyrights. Summarize what you find.
12. Using a generative AI tool, research how a generative AI tool can avoid copyright infringement when using training data. Summarize what you find.
13. Using a generative AI tool, what is the current status of Kelly McKernan's lawsuit?

9. DATASET DEVELOPMENT EXERCISE

A dataset development exercise with discussion questions can be found in the appendix. In this exercise, students will use a web scraping tool to garner images and image metadata from the internet based upon a selected theme. Once the images are retrieved, the data set will be filtered and cleaned to provide a usable data pool. Students are then asked to conduct an analysis of the pool images to identify ownership and copyright issues and then write a report of their findings. Discussion questions are provided that faculty may wish to discuss in class addressing the different types of screen scaping tools used, striking a balance between quantity and quality in light of copyright concerns, and ethical and legal considerations that must be considered as the pools are developed.

The assignment was not intended as a worksheet exercise but rather was created as an exploratory assignment for students to research and determine the best choices for fulfilling the needs of program development for the assignment. Because AI "scrapes" the internet for images like the copyrighted artwork at issue in the case, the authors prepared this exercise to familiarize students with these processes as well as the limitations and benefits of scraping tools.

The process of developing a data set generator for an AI tool is a significant undertaking requiring multiple phases, iterations, and development experience. The exercise described below was created for a junior level computer science data analytics or machine learning course.

The exercise was implemented in fall 2024. The course instructor focused on the mechanics of writing an AI program to perform the web scraping process rather than the copyright data. In the fall 2024 exercise implementation, the students learned how to scrape pictures from the Web, read the picture metadata, and then used that data to store the pictures in a usable format with similar dimensions. The data sets were then used to train an AI program the students had written to detect fake photos from real ones.

The students presented their results in front of the Computer Science Department's external advisory board. The board members were very complementary of the students' project and the objectives of the exercise. The students gained a significant amount of knowledge from the exercise. Future projects may also take the copyrights metadata into consideration.

10. REFERENCES

Brittan, B. (2024). Stability AI, Midjourney should face artists' copyright case, judge says. *Reuters,* Retrieved on June 12, 2024 from https://www.reuters.com/legal/litigation/stability-ai-midjourney-should-face-artists-copyright-case-judge-says-2024-05-08/

Chadwick, L. (2024). OpenAI says it's 'impossible' to train AI without copyrighted materials. *Euronews*. Retrieved June 12, 2024 from https://www.euronews.com/next/2024/01/09/openai-says-its-impossible-to-train-ai-without-copyrighted-materials

Chow, A. R. (2023, Sept. 7). Kelly McKernan, Artist. *Time*, Retrieved May 22, 2024 from https://time.com/collection/time100-ai/6309445/kelly-mckernan/

Davis, T. (2022, Oct. 15, 8:47 PM), (@DocSparse, Twitter (X)). Retrieved June 12, 2024 from https://x.com/DocSparse/status/1581461734665367554?lang=en.

Dean, I. (2023). Illustrator Kelly McKernan reveals the raw impact of AI on artists' lives. *Creative Blog,* Retrieved May 20, 2024 from https://www.creativebloq.com/features/ai-art-the-impact-of-generative-AI.

Gent, E. (2023). Public AI training datasets are rife with licensing errors: An audit of popular datasets suggests developers face legal and ethical risks. *IEEE Spectrum*, Retrieved August 12, 2024 from https://spectrum.ieee.org/data-ai

HOL CDSC (2023, Dec. 5). House of Lords Communications and Digital Select Committee inquiry: Large language models, OpenAI—written evidence (LLM0113) https://committees.parliament.uk/writtenevidence /126981/pdf/.

IPTC (2024a). *IPTC is the global standards body of the news media*. IPTC. https://www.iptc.org/about-iptc/

IPTC (2024b). *Photo Metadata Standard 2023.2*, IPTC. https://www.iptc.org/std/photometadata/specification/IPTC-PhotoMetadata

IPTC (2024c). *Quick guide to IPTC photo metadata on Google Images.* IPTC https://iptc.org/standards/photo-metadata/quick-guide-to-iptc-photo-metadata-and-google-images/

J. DOE 1, et al., Plaintiffs, v. GITHUB, INC., et al., Defendants, *Doe v. GitHub, Inc.*, 22-cv-06823-JST, (N.D. Cal. Jan. 3, 2024) Retrieved on June 12, 2024 from https://casetext.com/case/doe-v-github-inc-1

Kupferschmid, K. (2023, Dec. 13). Letter to U.S. House of Representatives Subcommittee on Courts, Intellectual Property, and the Internet Retrieved on May 22, 2024 from https://copyrightalliance.org/wp-content/uploads/2023/12/Copyright-Alliance-Piracy-Letter.pdf

Quinn, B. (2023). *Rights holders can exclude images from generative AI with IPTC Photo Metadata Standard 2023.1*, IPTC, https://www.iptc.org/news/exclude-images-from-generative-ai-iptc-photo-metadata-standard-2023-1/

Stoner, R. and Dutra, J. (2022). The International Intellectual Property Alliance (IIPA): Copyright Industries in the U.S. Economy, *2022 Report.* Retrieved May 20, 2024 from https://www.iipa.org/ files/uploads/2022/12/IIPA-Report-2022_Interactive_12-12-2022-1.pdf

Tyser, D. A. (2024). Rights granted under copyright law. *Bitlaw*. Retrieved December 28, 2024 from https://www.bitlaw.com/ copyright/scope.html

U.S. Copyright Office (n.d.). *A brief history of copyright in the United States.* Timeline, U.S. Copyright Office. Retrieved on May 22, 2024 from https://www.copyright.gov/timeline/

U.S. Copyright Office (2023). *Copyright Registration Guidance: Works Containing Material Generated by Artificial Intelligence*. Copyright Office. Retrieved on August 10, 2024 from https://www.copyright.gov/ai/ ai_policy_guidance.pdf

U.S. District Court, S.D. New York (2023, Dec. 27). The New York Times Company v. Microsoft Corporation, OpenAI, Inc., OpenAI LP, Open AI GP, LLC, OpenAI, LLC, OpenAI OPCO LLC, OpenAI Global LLC, OAI Corporation, LLC, and OpenAI Holdings, LLC. (1:23-cv-11195) https://nytco-assets.nytimes.com/2023/12/NYT_Complaint_Dec2023.pdf

Vincent, J. (2022, Nov. 8). The lawsuit against Microsoft, GitHub and OpenAI that could change the rules of AI copyright. *The Verge*. https://www.theverge.com/ 2022/11/8/23446821/microsoft-openai-github-copilot-class-action-lawsuit-ai-copyright-violation-training-data

Wilkins, A. (2022, Nov. 8). Microsoft's Copilot code tool faces the first big AI copyright lawsuit. *New Scientist*, Retrieved on June 12, 2024 https://www.newscientist.com/article/ 2346217-microsofts-copilot-code-tool-faces-the-first-big-ai-copyright-lawsuit/

APPENDIX – Dataset Exercise
Web Scraping for Digital Images and Image Metadata-

Objective: To use a web scraping script to collect images and their metadata according to a specified theme.

Context: The purpose of this assignment is to provide an exploratory exercise in which students learn about web scraping programs and the data that they can collect. Students will be responsible for web scraping images based on a specified theme, such as an artist's name, color palette, or genre. Image metadata will be collected and analyzed to determine what metadata is available for examination in regard to copyright issues.

Assignment Details:

1. Theme Specification:
   - Instruction: Each group will be assigned a specific theme for your web scraping task. Themes can include:
     - A particular artist's name (e.g., Vincent van Gogh)
     - A specific color palette (e.g., pastel colors)
     - A genre or style (e.g., surrealism)
   - Deliverable: Confirm the assigned theme with the instructor and document the theme in your report.
2. Web Scraping Task:
   - Instruction: Utilize web scraping tools (such as BeautifulSoup, Scrapy, or ParseHub) to collect a dataset of digital images related to the assigned theme.
     - Develop a web scraping script to automate the extraction of images and metadata. Pay attention to the website's structure and HTML elements.
     - How could the code be modified to handle potential issues such as CAPTCHA, pagination, and dynamic content loading?
   - Deliverable: A working web scraping script, a brief description of the scraping process, and suggestions for modifying the code.
3. Data Collection Requirements:
   - Instruction: Collect at least 100 digital images relevant to the theme. For each image, gather metadata including:
     - Source URL
     - Image resolution
     - File size
     - Any available licensing information
     - Any additional metadata
     - Store this data systematically for further analysis.
   - Deliverable: A dataset (in CSV or JSON format) containing the collected images and associated metadata.
4. Discussion Questions:
   - Trade-offs in Web Scraping Techniques: What are the trade-offs between using different web scraping tools? Discuss factors like ease of use, efficiency, ability to handle complex or dynamic web pages, and overall effectiveness in collecting the required data.
   - Data Collection Process: During the data collection process, what challenges did you face? Explain how you addressed those issues?
5. Deliverables:
   - A report (3-5 pages) detailing the web scraping process, data collection, issue resolution, and overview of metadata collected.
   - Content: The report should cover the following sections:
     - Introduction and objective
     - Theme specification
     - Web scraping methodology
     - Data collection summary
     - Discussion questions
   - Format: The report should be clear, concise, and professionally formatted.
   - The collected dataset of digital images in a compressed folder (e.g., zip).
   - A CSV or JSON file containing the metadata of the downloaded images.
   - Python scripts or Jupyter Notebooks used for web scraping and data analysis, with appropriate comments and documentation.