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Winning the game against fake news? Using games to inoculate adolescents and young adults in Singapore against fake news

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Abstract. Guided by inoculation theory and studies that examined serious games as a form of intervention to inoculate individuals against fake news, this study tested the impact on college (n = 84) and junior high and secondary school (n = 30) students of a fake news computer game developed in Singapore. The findings were replicated across both samples: Those who played the game subsequently improved in their self-reported scores on perceiving fake news as a threat, skepticism toward information from social media, and being cautious about believing in information they encounter online. We also found that those who played the game scored higher in detecting fake news than those who did not play the game–consistent with the predicted effects of message inoculation.
Keywords: Computer games; fake news; gamification; inoculation theory; Singapore

[es] ¿Ganar el juego contra las noticias falsas? Uso de juegos para inocular a adolescentes y adultos jóvenes en Singapur contra las noticias falsas

Resumen. Guiado por la teoría de la inoculación y estudios que examinaron los juegos serios como una forma de intervención para vacunar a las personas contra las noticias falsas, este estudio probó el impacto en estudiantes universitarios (n = 84) y de secundaria y preparatoria (n = 30) de una noticia falsa. juego de computadora desarrollado en Singapur. Los hallazgos se replicaron en ambas muestras: aquellos que jugaron el juego mejoraron posteriormente en sus puntajes autoinformados sobre la percepción de noticias falsas como una amenaza, el escepticismo hacia la información de las redes sociales y la cautela sobre creer en la información que encuentran en línea. También encontramos que aquellos que jugaron el juego obtuvieron una puntuación más alta en la detección de noticias falsas que aquellos que no jugaron el juego, de acuerdo con los efectos previstos de la inoculación de mensajes.
Palabras clave: Juegos de computadora; noticias falsas; ludificación; teoría de la inoculación; Singapur

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1. Introduction

Numerous studies have documented the wide-ranging consequences of fake news. It can lead to misbeliefs and confusion (Rapp & Salovich, 2018) as well as divert media and public attention away from important issues (Vargo et al., 2018). Fake news can also sow doubt and discord in elections and democratic processes (Maweu, 2019) and increase public health risks during health crises (Greene & Murphy, 2021; Naeem et al., 2021). In the short term, it can hurt interpersonal relationships and personal reputation (Duffy et al., 2020); in the long term, it may inadvertently harm the credibility of news and media organizations (Tandoc Jr. et al., 2021) and the reputation of businesses (Visentin et al., 2019), eroding public trust in institutions.

Thus, various stakeholders have introduced measures and efforts to combat fake news. For instance, journalists, media professionals, and non-profit organizations have ramped up fact-checking initiatives to reduce belief in fake news (Amazeen, 2019; Graves & Cherubini, 2016). Social media and tech companies have introduced regulations and content moderation to police information on their platform (Lien et al., 2022). Governments have introduced or passed legislations to punish the creators of fake news and curb its spread (Haciyakupoglu et al., 2018). Educators have implemented various media literacy programs to teach students how to navigate the online space and be more resilient to false information (Barzilai & Chinn, 2020). Yet, teachers may not be adequately trained to teach media literacy, and hence lack the confidence to teach about it (Gretter & Aman, 2018).

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Some initiatives take a more novel approach, such as "learning-by-doing," where students learn media and news literacy by creating news and content (Lim & Tan, 2020, p. 530). Another novel approach to teach media literacy is through serious games, where the goal of the game is to impart media literacy to players. For example, *MAthe* and *Trustme!* are serious games that incorporate quizzes and tools into a game to teach players how to verify information they encounter; the gamified elements and practice the game affords increase the effectiveness of the game as a media literacy teaching tool (Katsaounidou et al., 2019; Yang et al., 2021). While some regard older people as having higher susceptibility to fake news as they are said to be less tech-savvy than younger people (Brashier & Schacter, 2020), young adults and even adolescents may also be particularly susceptible due to their high levels of social media use, which many studies have found to be a breeding ground for fake news (e.g., Carlson, 2020; Naeem et al., 2021; Shahi et al., 2021; Sommariva et al., 2018). Thus, it is equally important to design interventions that appeal to young people as well, which explains why some have turned to serious games as a way to inoculate young people against fake news (Katsaounidou et al., 2019; Roozenbeek & van der Linden, 2019; Yang et al., 2021).

Such conceptualization of serious games as a form of inoculation borrows from the notion of medical inoculation, where the body is trained to detect a virus by exposing it to a weak dose of the virus to trigger the build-up of antibodies that will help the body to defend itself in the event it is exposed to the virus (Banas, 2020; McGuire, 1961). Applied to the context of using serious games as a form of intervention against fake news, a game can be designed as a form of inoculation to help players to build up subsequent immunity when exposed to actual fake news. For example, the *Bad News* game explains and demonstrates the strategies that creators and spreaders of fake news use, thereby increasing players' discernment of these strategies and their resilience toward fake news (Roozenbeek & van der Linden, 2019). Another game, *GoViral!*, follows the same concept, but targets COVID-19 misinformation. We follow this approach to examine the concept of inoculation against fake news using serious games in the context of Singapore, a small nation in Southeast Asia that has had its share of fake news, especially during the COVID-19 pandemic (Lwin et al., 2021). Singapore is a wealthy and technologically advanced nation-state known for its efficient information technology infrastructure, which also means its residents have been at risk to being exposed to fake news spreading online (Soon & Goh, 2021; Tandoc & Lee, 2022). To what extent can a serious game, where players are exposed to fake news and fact-checks, function as a form of inoculation to help players build up immunity to fight fake news? Focusing on college, junior high school, and secondary school students, this current study seeks to answer this question through an online experiment, where participants participated in a longitudinal study that involves them playing Fake News Detective (https://fakenewsdetective.com/), a serious game developed by undergraduate students and researchers at the Centre for Information Integrity and the Internet (IN-cube) at Nanyang Technological University in Singapore. Fake News Detective is designed as an inoculation game for secondary students in Singapore.

2. Literature Review

2.1. Inoculation Theory

Inoculation theory in communication studies posits that people's resistance to persuasion can be developed akin to medical inoculation where a weakened version of a virus is introduced to a body, allowing the body's immune system to generate antibodies against the virus, conferring greater immunity against future exposure to the virus (Banas, 2020; McGuire, 1961). It argues that exposing people to a weakened persuasive argument that contradicts their beliefs will trigger responses that "promote immunity to subsequent encounters with persuasive attacks" (Banas, 2020, p. 1). Coined by William McGuire, inoculation theory is based on the premise that when people's beliefs have never been challenged, they may assume these beliefs will not be challenged, and be over-confident in these beliefs, causing them to be vulnerable to persuasive messages attacking these beliefs (McGuire, 1961; McGuire & Papageorgis, 1962). But this vulnerability can be ameliorated when people are made to feel that these beliefs will be challenged, prompting them to increase their resistance to these challenges (McGuire & Papageorgis, 1962).

Inoculation studies usually involve two main elements. First is a forewarning element, which shows people that their beliefs are vulnerable to attacks, inducing a perceived threat to their beliefs (Banas, 2020; McGuire, 1961). This can be done implicitly by merely exposing people to an attacking message, or explicitly, by informing people that there will be persuasive messages attempting to change their beliefs (Compton, 2012). The attacking persuasive message, and induced threat to one's beliefs, motivates people to develop arguments to counter the attacking messages (Compton, 2012; McGuire, 1961). As a result, they would consider and think about potential attacks to their beliefs, and how they would counter these attacks (Clear et al., 2021). When people are exposed to an inoculation message, the induced threat to one's beliefs leads to greater attitudinal certainty and resistance to persuasion (Pfau et al., 2009). While inducing a threat to one's beliefs is required for inoculation, the level of threat does not affect the level of resistance to persuasion (Compton, 2021). Based on a meta-analysis of studies testing inoculation, the level of threat invoked by the inoculation message does not affect the effectiveness of the inoculation (Banas & Rains, 2010).

Second, after inducing a threat, a refutational pre-emption is shown, where the attacking persuasive message is immediately refuted, providing people time and materials to counterargue and refute the attacking persuasive message (Banas & Rains, 2010; Banas, 2020; McGuire, 1961). This increases their confidence in defending their beliefs as well as practicing their counterarguing strategies (Clear et al., 2021). Exposure to these refutations will reduce the effectiveness of future persuasive message using that argument (McGuire & Papageorgis, 1962) and increases self-efficacy in countering persuasive messages (Pfau et al., 2009). While a threat alone is sufficient to confer some resistance, if people are exposed to attacking persuasive messages as well as refutations to the attacking messages, people will develop greater resistance to persuasion (McGuire, 1961). A meta-analysis showed that inoculation–providing a persuasive message followed by refutation of said persuasive message–is more effective at reducing persuasion than no inoculation or providing only supportive messages (Banas & Rains, 2010). Refutations of a persuasive message is more effective at preventing persuasion and attitude change.

In its nascent, inoculation theory was applied solely to cultural truisms, which refer to "beliefs so commonplace that it was unlikely that anyone had even heard them attacked or believed it was possible" (Banas, 2020, p. 1). McGuire (1961) theorized that the lack of perceived threat to one's beliefs and the resultant cognitive countermeasures to the threat is what make people vulnerable to challenges, which they will have never considered or developed resistance. However, recent studies into inoculation theory have applied inoculation to controversial, hyper-partisan, and highly debated topics, where people are very likely to have heard challenges to their beliefs as well as refutations. Inoculation has been shown to be effective at building people's resistance to a plethora of topics, namely, health, advertising, jury trials, and even contested topics such as political campaigns, climate change, risky behaviors, and government regulations (Banas & Rains, 2010; Compton, 2012; Compton et al., 2021; Ivanov et al., 2020).

Other studies have also applied the notion of inoculation beyond inoculating people against persuasion attempts within specific topics to also examine broader forms of persuasion and deception. For example, Amazeen and Vargo (2021) focused on native advertising as a form of persuasion and found that disclosures of sponsored content on news articles on Twitter can successfully inoculate audiences against the persuasive attempt of native advertising. Inoculation is also effective in countering misinformation. Pre-bunking, which refers to showing people refutations to misinformation before they encounter the misinformation, can increase people's resilience toward falling for the misinformation (Amazeen et al., 2022). In the context of climate change misinformation, inoculating people about persuasive strategies used by creators of misinformation by explaining these strategies to people can increase resistance to misinformation that used those strategies; exposing people to false-balance media articles or challenges to scientific consensus on climate change, followed by refutations, can increase resistance toward misinformation about climate change (Cook et al., 2017; Lewandowsky & van der Linden, 2021; van der Linden et al., 2017). Likewise, in the context of conspiracy theories, exposing people to conspiracy theories followed by immediate refutations can inoculate people, reducing people's beliefs in the conspiracy theories if they were to encounter these in the future (Banas & Miller, 2013; Jolley & Douglas, 2017). However, inoculation is not infallible. Jolley and Douglas (2017) found that inoculation would not work if the conspiracy theories were already subscribed to prior to the inoculation process. If people are already inoculated against the persuasive attempts of the inoculation, inoculating against conspiracy theories will also be less effective (Banas & Miller, 2013). The form that an inoculation attempt takes has also expanded beyond just a single warning or attack message; studies have looked at serious games, for example, as a form of inoculation (Roozenbeek & van der Linden, 2019).

2.2. Serious Games as Inoculation

Serious games can be defined as games that "have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement" (Abt, 1970, p. 9). Such games convey to players certain content such as knowledge or skills, while still containing some entertainment elements (Laamarti et al., 2014). What differentiates serious games from other games, including those used for educational purposes, is the non-entertainment intention of the developers of the game (Marsh, 2011). Serious games can come in various modalities. Both digital and non-digital games–boardgames, text-based, video–have been created and studied as serious games (Connolly et al., 2012). However, most serious games studied by scholars are digital games (Connolly et al., 2012).

One reason for the heavy scholarly attention on serious games is the potential for serious games to improve learning outcomes in students. Game-based learning can provide students with a "no stress condition" compared with a classroom, increasing students' attention and understanding of the topic (Behnamnia et al., 2020, p. 7). The practical aspects of serious games also allow students to apply skills and theories learned in more realistic contexts, engaging in a more realistic practice that they would not get in a classroom setting (Chang et al., 2020; Shaffer, 2006). The experiential elements in serious games make the game more engaging and interactive, which can enhance students' learning (Kiili, 2005). Because of these advantages that serious games afford, numerous studies have found that serious games can improve learning experience and outcomes. For example, serious games have been shown to improve

learning outcomes in teaching about critical thinking (Halpern et al., 2012), nursing (Chang et al., 2020), creativity (Behnamnia et al., 2020), and crisis communication (Haferkamp et al., 2011).

Serious games have been found to be particularly effective among young people. A meta-analysis of experiments testing the effectiveness of serious games on learning shows that serious games can improve students' engagement and motivation toward learning, as well as improve their absorption of knowledge and skills (Lamb et al., 2018). This effect was most effective among students aged 12 to 13, followed by those 14 to 18 (Lamb et al., 2018). Because of the success of serious games in numerous contexts, scholars and educators have also attempted to apply serious games to media and information literacy (Urban, 2019). One such game is *MAthE*, which teaches players to verify news items through quizzes and verification tools, and was found to increase players' self-reported knowledge, ability, and willingness to verify information online (Katsaounidou et al., 2019). Another similar game is *Trustme!*, which teaches players to identify unreliable information on social media, but also the reasons the information is unreliable; *Trustme!* was found to improve players ability to evaluate information online, and is more effective than a non-gamified quiz, demonstrating the effectiveness of the game elements (Yang et al., 2021). While these games adopt a media literacy approach, with instruction and gamified practice, another serious game takes a different approach–inoculation.

The *Bad News* game allows players to take the role of a creator and spreader of fake news, choosing which social media posts to publish to further their objective of gaining followers for ideological, financial, and political gains; in doing so, the game introduces players to the strategies fake news creators use to fool people, such as impersonating trusted sources or evoking emotional responses (Roozenbeek & van der Linden, 2019). The game exposes players to strategies fake news creators use, weakened through "ridicule and humour" (Lewandowsky & van der Linden, 2021, p. 22). The creators of the game, Roozenbeek and van der Linden (2019), theorized that by exposing and explaining the strategies, the game inoculates players to these deception strategies, conferring some resistance toward fake news, and providing resistance to a broader range of fake news. The *Bad News* game was shown to improve players' confidence and ability to spot fake news headlines regardless of political ideology (Basol et al., 2020; Roozenbeek & van der Linden, 2019), across various cultural and political contexts, including Sweden, Germany, Greece, and Poland (Roozenbeek et al., 2020). This inoculation effect is effective up to two months and can be further extended with continuous inoculation (Maertens et al., 2021).

2.3. Skepticism and Caution

In line with inoculation theory, Roozenbeek and van der Linden (2019) tested the impact of being inoculated through playing a serious game on the players' subsequent susceptibility to the persuasiveness of fake news items, finding that those who played the game, and thus inoculated, tend to have higher resistance against believing in fake news. In this study, we also argue that interventions against fake news should also focus on building a healthy dose of skepticism and caution among the public. That is, the public must realize that not everything they see online and on social media is true (Vraga & Tully, 2021). Indeed, skepticism is considered to be integral to resilience toward fake news, and has been shown to be associated with news literacy (Maksl et al., 2015; Vraga & Tully, 2021). We argue that skepticism must also be accompanied by caution. In the context of fake news, the public must be cautious about believing and spreading information at a time when receiving and sharing information, accurate and not, has become much easier.

Studies have found that after people are inoculated against deceptive or manipulative content, they will perceive the source of the content as less credible, honest, and trustworthy (Lim & Ki, 2007; Pfau et al., 2007). We hope that this skepticism will also be applied to other sources and messages. Thus, we argue that inoculation must also result in skepticism and caution regarding information that we encounter. Indeed, in the context of fake news, studies have also found that people tend to display more hesitation and care when sharing information when they doubt its truthfulness, double checking or paying closer attention to details to the information (Duffy et al., 2020; Waruwu et al., 2021). At the same time, research has also found that when people engage in greater cognitive involvement, reasoning, and deliberation when processing fake news, they are less likely to believe it (Bago et al., 2020; Pennycook & Rand, 2019).

3. Study 1

Taking cue from previous studies that developed and tested serious games as a form of inoculation and realizing that inoculation games against fake news have been mostly developed in Western contexts, we also developed a computer game in Singapore that incorporates local examples of fake news that have gone viral: *Fake News Detective*.[3] The game is designed for young players, aged 16 and above. It is a third-person, single-player, role-playing-game where the player explores a map and completes tasks to find the mastermind behind a series of fake news. The game starts with a forewarning message, telling the player that the world is facing a serious threat from fake news, and that one way to address it is to find the mastermind behind the creation of fake news. In their pursuit of the mastermind, players will encounter information about fake news, and the steps people

[3] The game can be accessed and played here: https://fakenewsdetective.com/#/

can take to verify information they encounter. The game also features a series of quizzes where players are shown real and fake news articles and have to guess if these articles are fake or not. After each article, players are shown an explanation of the cues or steps that they could have taken to judge the veracity of that article. The fake news articles chosen were actual fake news items that circulated in Singapore, and the pedagogical elements of the game were tailored to the Singapore context. Real news items that may appear impossible or potentially fake, such as a road in Germany being flooded by chocolate, were also included to increase external validity. This current study examines whether this particular game developed in Singapore can also act as a form of inoculation for young players against fake news. Guided by inoculation theory and the literature on fake news and serious games, as well as focusing first on college students (aged 18-25), we propose the following hypotheses:

H1. Those who played the game will increase their a) threat perception, b) confidence, c) skepticism, and d) caution more than those who did not play the game.
H2. Those who played the game will score higher in fake news detection than those who did not play the game.

3.1. Method

Following approval from our University's research ethics review board, we recruited 100 college students from a large university in Singapore to participate in the experiment. They were randomly assigned to one of two groups: the treatment or the control conditions. The participants first filled out an online questionnaire for the pretest, which asked baseline measures across a number of variables, including those that are the main focus of the study. Then, those in the treatment group were sent a link to play the game, while no such links were sent to the control group. Two days after, the participants were sent a link to the posttest online questionnaire. Those who did not complete both questionnaires or displayed straight-line answers were excluded from the analysis, leaving Study 1 with 84 participants divided into the treatment (n = 51) and control (n = 33) groups. We had oversampled for the test treatment group to account for potential attrition.

We sought to compare the control and treatment groups based on the following measures: recognition of fake news as a threat, confidence in detecting fake news; social media skepticism; caution against information online; and ability to detect fake news. The first four variables were measured in both the pretest and the posttest while ability to detect fake news was measured only in the posttest. *Threat recognition* was measured using two items that correlated well in both pretest (r (84) = .74, p < .01) and posttest (r (84) = .82, p < .01). Using a 5-point Likert scale, participants were asked to rate the extent to which they agree with the following statements: "I have believed in a post that turned out to be fake," and "I have been misled by fake news before." These items developed for the study sought to measure the extent to which the participants feel fake news is a threat to them personally by asking whether they think they have fallen for fake news before.

Next, *confidence* was measured using five items rated on a 5-point Likert scale: "I am able to tell which articles on social media are fake;" "I know how to verify whether what is shared on social media is correct;" "I know how to use different sources of information to verify information I see on social media;" "I can tell whether a piece of information on social media is true or false;" and "I am confident about my ability to identify whether an article is fake news." The scale is reliable in both pretest (Cronbach's alpha = .87) and posttest (Cronbach's alpha = .82). *Skepticism* was measured by a single item that was rated on a 5-point Likert scale and was reversed coded: "Information I find online, including on social media, is trustworthy." *Caution* was also measured by a single item, also rated on a 5-point Likert scale: "I am careful about believing in information being passed around online." In Time 2, this was modified into future tense (i.e., I will be…).

Finally, *fake news detection* was measured by asking participants to rate on a 5-point scale, from Definitely False (1) to Definitely True (5), four statements that were adopted from fake news posts that had gone viral and debunked by the authorities in Singapore (at the time of the study): "A study found that PCR and ART swabs are coated with cancer-causing substances;" "Pfizer CEO Albert Bourla himself remains unvaccinated against COVID-19;" "Countries with the highest vaccination rates also have the highest cases/deaths per million population; and "Ivermectin, a prescription-only medicine for the treatment of parasitic worm infections, has been medically proven to be effective against COVID-19." The four fake news items were reverse coded so that composite score refers to ability to detect fake news (see Table 1 for the descriptives).

3.2. Results

H1 predicted that those who played the game will increase their a) threat perception, b) confidence, c) skepticism, and d) caution from the pretest to the posttest more than those who did not play the game. We ran a series of repeated measures ANOVA to test each of these, where condition (played vs. did not play the game) was a between-subjects factor. First, the analysis showed a significant interaction effect between threat perception (pretest vs posttest) and condition (played vs. did not play the game), F (1, 82) = 6.23, p < .05, *partial eta*^{2} = .07. Those who played the game increased their threat perception from pretest (M = 3.02, SD = 1.10) to posttest (M = 3.47, SD = .99); in contrast, threat perception among non-players stayed the same, from pretest (M = 3.23,

SD = 1.08) to posttest (*M* = 3.23, *SD* = 1.13). Thus, H1a is supported.

However, no significant interaction effect was found between confidence (pretest vs posttest) and condition (played vs. did not play the game). All participants seemed to have improved in their level of confidence from pretest to posttest, F (1, 82) = 5.66, $p < .05$, *partial eta*^{2} = .07, regardless of whether they played the game (*M* = 3.78, *SD* = .63; *M* = 3.93, *SD* = .39) or not (*M* = 3.81, *SD* = .71; *M* = 3.95, *SD* = .59). Thus, H1b is not supported.

Next, a repeated measures ANOVA showed that the interaction effect between skepticism (pretest vs posttest) and condition (played vs. did not play the game) approached the conventional threshold of significance, F (1, 82) = 3.09, p = .08, *partial eta*^{2} = .04. Those who played the game increased their skepticism from pretest (*M* = 2.80, *SD* = .66) to posttest (*M* = 3.00, *SD* = .80); in contrast, threat perception among non-players slightly decreased, from pretest (*M* = 3.00, *SD* = .79) to posttest (*M* = 2.88, *SD* =.78). While the effect size is small, this is in the predicted direction; H1c is supported.

Similarly, we also found that the interaction effect between caution (pretest vs posttest) and condition (played vs. did not play the game) approached the conventional threshold of significance, F (1, 82) = 3.70, p = .06, *partial eta*^{2} = .04. Those who played the game increased their caution from pretest (*M* = 4.02, *SD* = .79) to posttest (*M* = 4.35, *SD* = .56); in contrast, threat perception among non-players stayed the same, from pretest (*M* = 4.33, *SD* = .65) to posttest (*M* = 4.33, *SD* =.48). H1d is also supported.

H2 predicted that those who played the game will score higher in fake news detection than those who did not play the game. An independent samples t-test showed that game players performed better in fake news detection (*M* = 4.23, *SD* = .68) than those who did not play the game (*M* = 3.93, *SD* = .60), t (82) = 2.05, $p < .05$. Thus, H2 is supported.

4. Study 2

Cognizant of the literature that showed that serious games may be particularly effective among younger players, as well as to validate our Study 1 findings using another sample of players, we also ran the experiment among secondary school and junior high school students in Singapore (aged 16-18). Since Study 1 showed that those who played the game improved in their threat perception, skepticism, caution, and fake news detection after playing the game but not those who were in the control condition, Study 2 focuses on players, and examined if the game would yield the same results among younger players. Hence Study 2 was designed with only the treatment condition. Thus, we also test the following hypothesis:

H3. Participants will increase their a) threat perception, b) confidence, c) skepticism, and d) caution between pretest and posttest.

Informed by literature that serious games may have differential effects based on players' age, i.e., that games as a form of inoculation may be particularly effective for younger people (Lamb et al., 2018), as well as to examine how our hypothesized inoculation effects may contribute toward improving fake news detection ability, we also propose the following research questions:

RQ1. Is the game more effective among younger participants when it comes to increasing a) threat perception, b) confidence, c) skepticism, and d) caution?

RQ2. To what extent do a) threat perception, b) confidence, c) skepticism, and d) caution predict fake news detection?

4.1. Method

Following approval from our University's research ethics review board, we recruited 60 secondary school and junior high school students from three schools in Singapore. For this study, we focused on comparing pretest and posttest scores after playing the game; hence, everyone received the treatment. We obtained parental consent before sending them the links to the questionnaires and the game. Only 30 participants completed both pretest and posttest questionnaires.

Study 2 employed the same procedure and measures as Study 1, with the exception of having a control condition. The composite measures also hold up even with a younger sample: Threat perception items were strongly correlated in both pretest (r (30) = .83, $p < .01$) and posttest (r (30) = .83, $p < .01$). Similarly, confidence items formed a reliable scale in both pretest (*Cronbach's alpha* = .85) and posttest (*Cronbach's alpha* = .86). Skepticism and caution were both measured using single item questions, while the same items in Study 1 were used to measure fake news detection.

4.2. Results

H3 predicted that junior high school and secondary school players will increase their a) threat perception, b) confidence, c) skepticism, and d) caution between pretest and posttest. First, a paired samples t-test showed a significant increase in threat perception among the players, t (29) = 3.09, $p < .01$, from the pretest (M = 3.35, SD = 1.15) to posttest (M = 3.87, SD = .80). Thus, H3a is supported. However, paired samples t-test showed no significant change in confidence among players, t (29) = –1.49, p = .15, from the pretest (*M* = 3.84, *SD* = .71) to posttest (*M* = 4.06, *SD* = .70). H3b is not supported.

Next, paired samples t-test showed a significant increase in skepticism among players, t (29) = –2.28, $p < .05$ from the pretest (*M* = 2.73, *SD* = .83) to posttest (*M* = 3.17, *SD* = .83), providing support

to H3c. Similarly, analysis showed a significant increase in caution among players, t (29) = –7.09, p < .001, from the pretest (M = 3.84, SD = .66) to posttest (M = 4.63, SD = .44). Thus, H3d is supported.

These findings are similar to Study 1 results that involved college students. Therefore, RQ1 asked whether the game as a form of inoculation was more effective among junior high school and secondary school students than college students. Informed by the earlier results, we focused on comparing college students and younger students in terms of a) threat perception, b) skepticism, and c) caution. First, a repeated measures ANOVA showed the interaction effect between threat perception (pretest vs posttest) and age (college vs junior high and secondary school) is not significant, F (1, 79) =.101, p = .75. Everyone who played the game, regardless of age, increased their threat perception from pretest (M = 3.19, SE = .13) to posttest (M = 3.67, SE = .10), F (1, 79) = 21.88, p < .001, *partial eta*^{2} = .22.

Next, analysis also showed that the interaction effect between skepticism (pretest vs posttest) and age (college vs junior high and secondary school) is not significant, F (1, 79) =1.33, p = .25. Everyone who played the game, regardless of age, increased their skepticism from pretest (M = 2.77, SE = .08) to posttest (M = 3.08, SE = .09), F (1, 79) = 9.32, p < .01, *partial eta*^{2} = .11. Finally, we also found no interaction effect between caution (pretest vs posttest) and age (college vs junior high and secondary school), F (1, 79) =.131, p = .72. Everyone who played the game, regardless of age, increased their caution from pretest (M = 4.13, SE = .09) to posttest (M = 4.49, SE = .06), F (1, 79) = 15.88, p < .001, *partial eta*^{2} = .17.

Combining both college and younger students, RQ2 asked to what extent do a) threat perception, b) confidence, c) skepticism, and d) caution predict fake news detection ability. To answer this, we conducted a regression analysis. Post-test scores for these variables were all entered into the equation. The regression model is significant, F (8, 72) = 4.08, p < .001, accounting for 24% of the variance. However only two variables were found to be related with fake news detection: confidence (b = .34, p < .01) and caution (b = .23, p < .05).

5. Discussion

Guided by inoculation theory and studies that examined serious games as a form of intervention to inoculate individuals against fake news, this study tested the impact on college and junior high and secondary school students of a fake news computer game developed in Singapore. The findings were replicated across both samples: Those who played the game subsequently improved in their self-reported scores on perceiving fake news as a threat, skepticism toward information from social media, and being cautious about believing in information they encounter online. These results are consistent with the assumptions of inoculation theory as well as with the findings of previous studies showing that serious games can be effective in inoculating players against fake news (Katsaounidou et al., 2019; Roozenbeek & van der Linden, 2019; Yang et al., 2021). We also found that those who played the game scored higher in detecting fake news than those who did not play the game–consistent with the predicted effects of inoculation (Cook et al., 2017; Lewandowsky & van der Linden, 2021). Thus, our findings add to the growing line of evidence showing the strong potential of serious games to inoculate young people against fake news.

In contrast to previous studies (Roozenbeek & van der Linden, 2019), we found that our serious game did not increase the players' confidence in their ability to detect fake news. However, this may be an encouraging finding. Some studies found that while some people may be confident in their ability to spot fake news, their actual capability may not be at par (e.g., Lyons et al., 2021). In psychology, scholars have documented the Dunning-Kruger effect, which refers to how some people may be ignorant of their ignorance–their perceived expertise on a subject may be unmatched by their actual expertise (Dunning, 2011). Thus, we argue that lowering one's confidence in their ability to detect fake news may not necessarily be a bad thing–in contrast, this may be a positive development if lower confidence gives way to a healthy dose of skepticism. This current study found that playing a serious game about fake news can increase social media skepticism as well as caution. Future studies can examine the linkages between confidence, skepticism, and caution in the context of online information processing.

The findings presented here must be examined in the context of several limitations. First, we focused on the specific context of Singapore, designing our computer game based on local examples of fake news. Future studies may want to examine the effectiveness of the specific computer game we designed in other contexts, as well the impact of serious games on public response against fake news. Second, we also focused on a specific age range–young people (i.e., secondary and junior high school, and college students). While testing across two groups allowed us to replicate our findings, we also recognize that older individuals may respond differently to serious games as a form of inoculation. Thus, future studies may want to test the effects of the computer game we designed among older players. Third, as the fake news items in the game were real pieces of fake news circulating, some participants may have encountered some of these fake news or their respective fact-checks prior to playing the game. This may have affected the extent to which some players assessed the items; however, this is also one goal of the game, which is to serve as a fun platform where players can encounter the necessary fact-checks for some fake news items they may have come across. Finally, since the target audience

of the game are secondary school students, we included only age-appropriate examples of fake and real news in the game. Future initiatives can build on the game we have developed and the findings we have from the experiments in developing and testing serious games for older generations.

Table 1. Descriptives of Key Variables

	College Students				Secondary School and Junior High School Students	
	Control		Treatment		Treatment	
	Pre	Post	Pre	Post	Pre	Post
Threat Recognition	3.22	3.22	3.01	3.47	3.35	3.87
Confidence	3.81	3.95	3.78	3.93	3.84	4.06
Skepticism	3.00	2.88	2.80	3.00	2.73	3.17
Caution	4.33	4.33	4.02	4.35	4.23	4.63
Fake News Detection		3.93		4.23		4.38

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