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Designing A Scalable Intervention for Adult Learners' Negative Academic Self-concept

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Short Paper

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Abstract

Information technology is key to developing efficient tools in traditional education. Little is known, however, about how information technology should be leveraged in continuing education, which is of increasing importance in recent years. This paper aims to meet this research gap by extending a design science research model to adult education. Specifically, we follow the DSR model to design a scalable intervention targeting negative academic self-concept in adult education, a key challenge confronting adult learners. This intervention design will leverage augmented reality to deliver a growth mindset of intelligence. On the one hand, augmented reality contributes to active information processing, benefiting adult learners to efficiently build a growth mindset of intelligence. On the other hand, augmented reality provides adequate scalability and flexibility for repeat, relieving the implementation limitation. To summarize, by presenting the way to leverage information technology in continuing education, this study makes both theoretical contributions and practical implications.

Keywords: Adult Education, Academic Self-concept, Augmented Reality, Educational Intervention

Introduction

Academic self-concept, defined in educational literature as people's knowledge and beliefs about themselves in academic achievement settings, has long been viewed as a crucial component in educational psychology (Arens et al. 2021). It is typically created as a result of one's experiences in a learning environment, including academic interactions with peers and instructors (Brunner et al. 2009), and is well found to have significant impacts on students' academic achievement and educational attainment (Arens et al. 2017; Wu et al. 2021). Having a positive academic self-concept can promote students' in-class engagement and academic performance (Rothes et al. 2014; Wu et al. 2021), but forming a negative one can contribute to students' silence in group discussions (Cooper and Brownell 2016), test anxiety (von der Embse et al. 2018), and school dropout behaviours (Brumariu et al. 2022).

However, adult learners, who are part-time students with full-time jobs in undergraduate programs (Knowles 1978), may easily build a negative rather than a positive academic self-concept (e.g., Jameson and Fusco 2014). While this issue has also been frequently discussed in traditional education (Brumariu et al. 2022), adult learners are more likely to suffer from it than their traditional peers due to two primary reasons. First, adult learners' unfamiliarity with learning contributes to their negative academic self-concept. According to Zacharakis et al. (2011), many adult learners returning to school have a significant amount of time since their previous educational experience. As a result, they may perceive themselves as novices in the educational environment and then have a negative self-concept regarding their academic skills (Giancola et al. 2009; Newbold et al. 2010; Tones et al. 2009). Furthermore, adult learners' negative perception of how others see them in the learning environment also contributes to their negative self-concept. An age-based stereotype threat has been known to greatly affect adult learners when it comes to arithmetic performance (Lamont et al. 2015). As this stereotype implies that adult learners are not as cognitively capable as traditional students, it can negatively impact adult learners' judgments of their own abilities (Hollis-Sawyer 2011; Jameson and Fusco 2014).

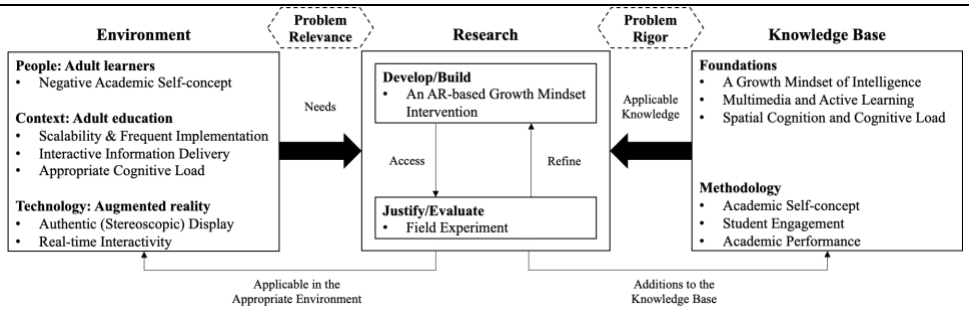

Figure 1. Design Science Research Framework

While adult learners can greatly suffer from building a negative academic self-concept (Jameson and Fusco 2014), few efforts have been made to help adult learners overcome this issue. Given the increasing importance of adult education in recent decades, we aim to build an intervention targeting adult learners' negative academic self-concept in this study. We take the design science approach to develop the intervention, as shown in Figure 1. Following the well-known design science research (DSR) model proposed by Hevner et al. (2004), we first identify the target problem as dealing with adult learners' negative academic self-concept. Then we analyze how to design an appropriate intervention to tackle this problem. Specifically, we consider three dimensions of this appropriateness: the intervention content; the content delivery format; and the intervention format. First, the intervention content should mitigate the two leading reasons for adult learners' negative academic self-concept mentioned above. Second, the intervention content should be delivered in an efficient way for adult learners to process. Last, the intervention format should fit the context of adult education. According to our analyses in Table 1, we perceive that building a growth mindset of intelligence can meet the first dimension and the Augmented Reality (AR) technique should be leveraged to meet the second and third dimensions. In this way, we address the importance of having a growth mindset of intelligence as the theoretical foundation and AR as the technological foundation to deal with adult learners' negative academic self-concept. Next, we present an exemplary implementation of our intervention. Finally, we will evaluate our design through a series of experiments and come to our conclusion.

Intervention Foundations	Functions
Theoretical foundation: A growth mindset of intelligence, which is a mindset stating that personal characteristics, such as intelligence or morality, can be altered and developed (Dweck 2006).	**Mitigating unfamiliarity of learning:** As illustrated above, unfamiliarity may lead to adult learners' stress about learning (Giancola et al. 2009; Zacharakis et al. 2011). Being anxious about learning, students dare not to try challenging tasks due to uncertainty about outcomes or easily get even more afraid or resistant if they try and fail. However, students with a growth mindset will build a positive psychological status when facing failure and challenges (DeBacker et al. 2018). With this positive attitude, adult learners may no longer worry about their rusty learning skills and pay more attention to efforts and improvement rather than failure, as they believe their abilities can grow when they work hard on challenging tasks—and thus that struggle is an opportunity for growth, not a sign that they are incapable of learning.
	Avoiding age-based stereotype threats: Building a growth mindset of intelligence has been shown to help students who are threatened by race-based stereotypes to characterize adversities as common and improvable (Yeager et al. 2016). Similarly, as this mindset also challenges the assumption of age-based stereotypes by suggesting "the intelligence can grow as long as you learn", it can make adult learners less prone to the stereotypes but perceive difficult tasks as an approach to improve their abilities and actively seek out challenging learning experiences that allow them to do so.

Technological foundation: Augmented reality, which is a technique creating a real-time view of a physical, real-world environment that is "augmented" with computer-generated perceptual information, ideally across many sensory modalities, such as visual, auditory, and haptic (Krüger et al. 2019).	**Facilitating active information processing:** Active learning has been known to benefit adult learners greatly more than passive learning (Mayer 2003). To get adult learners engaged in active information processing, an effective way is to present key information interactively. The more interactive the course design, the greater the students' perceived learning and the more interactive the instructor, the more the students participated (e.g., Kauffman 2015). Then, in our context, to maximize the impact of the growth mindset message, it is necessary to create an interactive instruction environment, which will make adult learners actively process the message. According to extant literature, such an environment could be well provided with the AR technique, given the interactivity feature of AR-based information.
	Avoiding extraneous cognitive overload issues: To effectively deliver a growth mindset of intelligence message, it is necessary to present scientific evidence on the structure and functions of the human brain (DeBacker et al. 2018). However, text-based and picture-based presentations of the evidence will require adult learners to visualize the relevant spatial concepts by themselves, which depends on their own sense of space and may demand great mental effort. As a result, adult learners may suffer from extraneous cognitive overload issues, which limit the effectiveness of the growth mindset message. But these issues can be mitigated by directly presenting stereoscopic information with the AR technique, as this technique enables the authentic display of key spatial concepts. For example, Price et al. (2015) have identified the superiority of stereoscopic over 2D information in delivering galaxy-related spatial concepts. They further stated that the stereoscopic format helps to generate learning gains in adults' long-term memory. In this way, to help adult learners efficiently understand the intervention content, it is necessary to leverage the AR technique.
	Enabling scalability & flexibility of repeat: Scalability and cost-effectiveness have been identified as the global priority for intervention design (Yeager et al. 2019). This priority should be particularly paid attention to in adult education. On the one hand, the increasing number of adult learners worldwide indicates the demand for an intervention that can be implemented for numerous adult learners simultaneously (Bellare et al. 2023). On the other hand, the great variety of adult learners' experiences and backgrounds implies the need for an intervention that can repeat and function in various contexts (Housel 2020). By involving the AR technique in our intervention, adult learners can benefit from its nature of scalability and flexibility (Blattgerste et al. 2021; Qiao et al. 2019).

Table 1. Theoretical and Technological Foundations for an Appropriate Intervention

This study has great contributions in several ways. First, we suggest that digitizing education is not only about developing learning systems to provide better online learning services but also about designing scalable social-psychological interventions to deal with students' psychological challenges. Most extant studies focus on students' learning challenges (Huang et al. 2021; Leung et al. 2023), but may ignore their psychological issues, such as negative academic self-concept. By illustrating how a scalable and cost-effective technology-based intervention may benefit adult learners in overcoming their negative academic self-concept, we expect to raise awareness about the value of technology in digital education. Second, we extend the DSR model to the education field. While this model has been well discussed in some IS research

areas, such as digital business and organization management (Silic and Lowry 2020), it is rarely followed in the digital education field. However, this study shows its value to develop educational interventions. Following the DSR model, we comprehensively analyze the target problem, the target population and the target context, which ensures the effectiveness of our intervention. Third, we fill the research gap in mitigating adult learners' negative academic self-concept. Lastly, our study also has critical practical implications for the stakeholders of adult education, such as online learning platforms.

Literature Review

Target Problem as Negative Academic Self-concept for Adult Learners

Academic self-concept is one of the key constructs that have long piqued the curiosity of educational and psychological researchers. It refers to people's knowledge and views about themselves in general and in different academic domains (Brunner et al., 2010). Numerous prior studies have shown that developing a negative academic self-concept will make students draw maladaptive self-attributions from academic outcomes: successes due to external causes and failures due to a lack of ability (Stiensmeier-Pelster and Heckhausen 2018). Explaining academic outcomes in this way, students can be greatly demotivated and likely to give up on challenging tasks, finally obtaining unsatisfying learning outcomes. While academic self-concept has been structured by many researchers as a multidimensional and hierarchical construct (Arens et al. 2021), we focus on adult learners' general academic self-concept in this study, as leading reasons for adult learners' negative academic self-concept that we summarize from the extant literature primarily influence adult learners' self-perceptions regarding their general academic skills.

Adult learners can greatly suffer from negative academic self-concept (Lim 2001; Kasworm 2008; Giancola et al. 2009). Other than reasons for negative academic self-concept in traditional education, such as historical academic failures (Wu et al. 2021), the unfamiliarity with learning and the age-based stereotype threat in adult education may further lead to adult learners' negative academic self-concept. Many adult learners are known to have been out of campus for a long time, during which they might have gained many life skills but not necessarily academic skills, and this can cause their unfamiliarity with learning and also anxiety about school (Zacharakis et al. 2011). Then when returning to campus, they may perceive themselves as novices in the educational environment and so have a negative self-concept regarding their academic skills (Giancola et al. 2009). Ross-Gordon (2003) backs up this assertion, citing many studies that show adult learners feel underprepared and build a negative academic self-concept when compared to their more traditional college counterparts. In addition, adult learners may build a negative age stereotype about themselves, which can also explain their negative self-concept. There has been a common stereotype about students on campus that traditional college students should be between the ages of 18 and 22 years (Stokes 2006). Compared to these traditional college students, adult learners who are usually elder than 24 years old are likely to suffer from an age-based stereotype threat, which refers to the deteriorating cognitive competence with ageing (Lamont et al. 2015). Although it is not the fact that adult learners' cognitive competence can really be significantly lower than their traditional peers, Lamont et al.'s review (2015) showed the damaging impact of having such a stereotype on people's memory competence. Once adult learners build a negative age stereotype, they can be easily threatened by learning challenges and then attribute their failure in challenging tasks to the perceived decreasing cognitive capabilities, thus gradually developing a poor academic self-concept, after which they may develop self-protective strategies, for instance, devaluing situations and activities in which one expects to be poorly evaluated, self-serving attributions, passive self-regulated strategies such as procrastination and withdrawal of effort, avoiding help-seeking, and strategic self-presentation (Lamont et al. 2015).

In summary, adult learners may considerably suffer from negative academic self-concept, which makes them attribute their success to external reasons and their failure to a lack of ability, finally getting demotivated and afraid of taking on challenging tasks. To solve this issue, we perceive the importance to encourage adult learners by changing their mindset about failure and challenging tasks. According to our knowledge, building a growth mindset of intelligence can be helpful in this case.

Theoretical Foundation as A Growth Mindset of Intelligence

Individuals hold one of two mindsets on how personal characteristics influence life experience in general (Dweck 2006). While a fixed mindset holds that characteristics such as intellect or morality are fixed,

immutable traits, a growth mindset argues that such personal characteristics can be altered and developed. These mindsets can help academics explain the internal psychological processes that influence external behavioural efforts to succeed by providing a framework. Individuals with a growth mindset, for example, respond to failure in a mastery-oriented manner, focusing on effort and improvement approaches (Dweck et al. 1995). This response is typically followed by an improvement in performance. When faced with failure, those with a fixed mindset are more likely to do the opposite.

Adult learners may overcome their negative academic self-concept by developing a growth mindset of intelligence. First, this mindset can mitigate the negative impact of the unfamiliarity of learning. As illustrated above, the unfamiliarity is known to frequently lead to adult learners' anxiety about learning (Zacharakis et al. 2011). Being anxious about learning, students usually dare not to try challenging tasks due to uncertainty about outcomes or easily get even more afraid or resistant if they try and fail (Mueller et al. 1992). However, such a situation can be avoided by developing a growth mindset of intelligence, as it encourages students to have a positive psychological status in the face of failure and challenges (DeBacker et al. 2018). With a growth mindset of intelligence, adult learners may no longer worry about their rusty learning skills and pay more attention to efforts and improvement rather than failure, as they believe their abilities can grow when students work hard on challenging tasks—and thus that struggle is an opportunity for growth, not a sign that they are incapable of learning. Moreover, this mindset also prevents adult learners from internalizing age-based stereotypes. Yeager et al. (2016) showed that building a growth mindset helps students suffering from negative race-based stereotypes characterize adversities as common and improvable. Similarly, as the growth mindset of intelligence challenges the assumption of age-based stereotypes that old students cannot learn as well as young ones by suggesting "the intelligence can grow as long as you learn", adult learners should be less prone to such stereotypes if they interiorize the growth mindset, but perceive difficult tasks as an approach to improve their abilities and actively seek out challenging learning experiences that allow them to do so (Blackwell et al. 2007).

In this way, we aim to help adult learners build a growth mindset of intelligence with our intervention. Then the question comes to how to build this mindset for adult learners. According to extant studies (e.g., Burnette et al. 2013; Yeager et al. 2019), there are two key steps to building this mindset. First, students should learn this mindset. It is about learning the scientific findings which show that the human brain can grow stronger by trying more challenging tasks, no matter who you are. By comparing how the brain works in different conditions, students should understand and believe that the brain can grow for everyone. Then, students should internalize this mindset. After knowing more about the brain, students should be seduced to think about their failures in challenging tasks and to explain these failures with a growth mindset. Such a change in the way to explain failures may further contribute to the change in students' positive thoughts about learning, which finally leads to a positive change in their academic self-concept. Following these studies, we should have two key components in our growth-mindset intervention to teach adult learners the mindset first and then to seduce adult learners to think with this mindset. However, changing one's mindset can always be difficult. To activate the impact of these two components, we further consider adult learners' information processing needs and the feature of adult education to develop the intervention.

Technological Foundation as Augmented Reality

In this subsection, we introduce how we facilitate the impact of our intervention by considering adult learners' needs and the feature of adult education. We identify the importance of the information presentation format for adult learners and the importance of the intervention format in the context of adult education. First, the intervention content should be delivered in an efficient way for adult learners to process. On the one hand, adults should benefit more from active information processing than passive information processing (Huang 2002). On the other hand, adults generally prefer stereoscopic information to non-stereoscopic information in the era of technology, as it decreases the mental efforts to visualize certain concepts (Halik and Kent 2021). Second, given the increasing number of adult learners and the various backgrounds of adult learners, the intervention should be digitalized to enable scalability and flexibility of repeat (Housel 2020).

Considering these requirements, we perceive the appropriateness of leveraging AR in our intervention. It is a real-time view of a physical, real-world environment that is "augmented" with computer-generated perceptual information, ideally across many sensory modalities, such as visual, auditory, and haptic. Its **real-time interactivity** and **authentic display** are known to distinguish it from other forms of

technology (Krüger et al. 2019). According to active learning and cognitive load theories, these two features can activate active information processing and provide appropriate cognitive load. The technological nature of AR also enables scalability and flexibility of repeat.

First, the **real-time interactivity** of AR arouses active learning behaviour among adult learners. As Mayer (2003) stated, meaningful learning happens when students actively analyze the information they receive and actively create mental representations. Instead of relying on mindless information absorption which may happen in the text- and picture-based interventions, adult learners can get immersed in exploration and interaction with AR-based information, through which they actively process the key information in the intervention and gradually organize their minds about the information into coherent verbal and photographic representations (Carroll and Mack 1999). This interaction process may further trigger adult learners' reflections about past relevant experiences which confirms the provided information, thus activating the internalization process and therefore leading to longer memory (Carroll and Mack 1999).

Second, the **authentic display** of AR prevents adult learners from extraneous cognitive overload issues. Humans are known to only have a finite amount of working memory to absorb incoming information; as a result, if one's working memory is overloaded, the learning effect declines (Baddeley 1992). However, the authentic display of AR enables us to present the key information in the intervention, such as the brain structure, in a stereoscopic format, which depends little on adult learners' own spatial cognition skills and demands them to just make little mental effort to visualize the information, thus benefiting adult learners from understanding the key information embedded in the intervention.

Lastly, the **technological nature** of AR enables the scalability and flexibility of repeat of the intervention. Compared to offline interventions in the form of workshops, AR-based intervention can be developed as a mobile application or a webpage, which can minimize the efforts for both students and institutions, thus being able to scale up and repeat frequently (Blattgerste et al. 2021; Qiao et al. 2019).

To summarize, this study proposes an intervention, which leverages AR to build a growth mindset of intelligence, to help adult learners overcome their negative academic self-concept. While the growth mindset of intelligence deals with the two leading reasons for adult learners' negative academic self-concept, AR contributes to the development of this mindset by activating active information processing, providing appropriate cognitive load and enabling scalability and flexibility of repeat.

Implementation of Design

We proceed to describe our exemplary implementation of the intervention in this section. We will implement our intervention in the Student Education System of a leading Asian university. Consistent with the two key steps mentioned in traditional interventions (e.g., Yeager et al. 2019), we have two key sequential components in our intervention shown as follows.

Teaching the Mindset: This component begins by introducing adult learners to the interactive structure of the human brain, with a focus on which part functions what (shown in Figure 2). Then adult learners will be shown visually and verbally how the brain changes (grows) when people of different ages complete tasks with different levels of difficulty and how such a grown brain benefits people of different ages in future tasks. To convince them, the intervention will also present the process of the relevant investigation process and scientific findings. Next, we expect adult learners to reflect on their related experience and describe it as a story in both written and spoken manners, in the process of which key hints, such as when, how, and why, will be visualized with AR. Lastly, we will present the designed visualization and polished audio records from other adult learners talking about their relevant experiences and inform adult learners that these records are from their peers in reality.

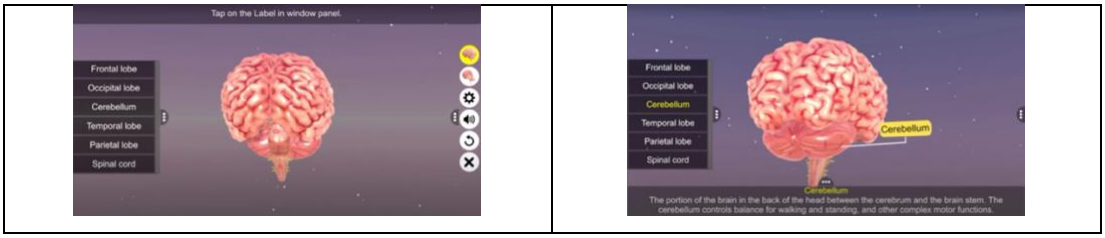

Figure 2. AR-based Brain Structure

Internalizing the Mindset: This component of our intervention requires adult learners to explain their failures in challenging tasks. It begins with a question asking about adult learners' perceptions of the value of challenging tasks, followed by a reflection on their failures in challenging tasks. Then adult learners are shown the scenarios of failure and are required to explain why they failed in those tasks verbally, as well as to record the answer in the text. Later, the intervention will play the designed visualization and polished audio records from other adult learners attributing their failure to their use of strategies and efforts made but not intelligence. Finally, adult learners should also give their own perceptions about the value of strategy use in both written and spoken manners.

Evaluation Design

In the next few months, we will first implement our AR-based intervention and text-based intervention (treatment vs. comparison). And then following the experiment design below, we evaluate the effectiveness and appropriateness of our AR-based intervention. In our assessment, we will use three outcome variables important to adult learners: (1) growth mindset of intelligence (adapted from Chen et al. 2023 and Dweck 2017); (2) academic self-concept (adapted from Reynolds 1988); (3) academic performance (exam grades). The differences in these outcomes between the treatment and other groups (comparison and control group) will be used to determine the effectiveness of the design.

Experiment Design

To evaluate the effectiveness of the intervention, we design a 3 (treatment vs. comparison vs. control) × 2 (pretest vs. posttest) field experiment. We plan to recruit 320 participants (20 for the pilot test and 300 for the main experiment) from continuing education programs at the Asian university we choose.

Pilot Test: Before we conduct our main experiment, we will test and check the quality of our design of the interventions and the scales. We will conduct cognitive interviews with 20 adult learners to know how they carry out the task of answering the questions and detect whether there will be any misunderstanding by concurrent verbal probing.

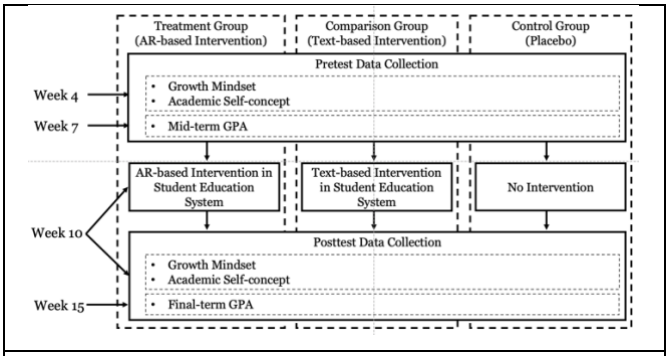

Figure 3. Main Experiment Process

Main Experiment (Figure 3): After we improve the quality of our experiment design process according to the results of the pilot test, we will conduct a field experiment in the next coming semester. To test our intervention's overall effectiveness, we expect a variety of majors and grades among the participants. To ensure such a variety, 300 adult learners are expected to participate and will be randomly divided into three groups (treatment, comparison, and control), thus finally having 100 participants in each group. In week 4 of the semester, during the first time the participants log in to the student education system, they will fill in the survey about growth mindset and academic self-concept. Then in week 10, during the first time participants log in to the student education system, participants in the treatment and the comparison groups will receive the corresponding intervention in the form of an invitation prompt named "an exercise to help students improve in school", after which the survey about growth mindset and academic self-concept should be filled. As for participants in the control group, they will only be prompted for the survey. At the end of the semester, we will collect the results of mid-term and final-term GPAs from the student

information database. After we receive all the outcome variables and demographical information for all groups, we will use MANOVA to evaluate our intervention.

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