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Original Research

How Does VR Customer Knowledge Education Promote Sustainable Product Purchase Intention? A Study Based on Self-Determination Motivation Theory

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Abstract

Virtual reality (VR) technology can promote sustainable consumption and pro-environmental behaviour. However, few studies have examined the psychological mechanisms that promote sustainable purchase intention from the perspective of VR education. Based on the self-determined motivation theory and VR attributes, this study proposes and empirically examines the underlying mechanism of VR customer knowledge education on sustainable purchase intention. The results show that VR customer knowledge education has a positive effect on customers' sustainable product knowledge levels, and subsequently, on sustainable purchase intention through the two mediators of knowledge richness and usefulness. Additionally, customers' intrinsic (versus extrinsic) learning motivation leads to a higher sustainable knowledge enhancement effect. Nonetheless, this effect is moderated by customers' prior sustainable knowledge; customers with low (versus high) prior sustainable knowledge are more susceptible to the effects of VR customer knowledge education.

Keywords: virtual reality, customer education, self-determined motivation theory, sustainable purchase intention, sustainable knowledge level

Introduction

Virtual reality (VR) technology has become increasingly prevalent in marketing and consumer education [1-2]. Customer education is effective in enhancing consumer brand awareness and changing consumer intentions. However, most current forms of green educational activities are mainly popular as science education. The creation of educational scenes is relatively single. The breadth and depth of educational content are insufficient, and the immersion and interaction effects of traditional educational activities for consumers are insufficient. VR education has significant advantages with regard to traditional physical scenarios in simulating real-world environments and creating multi-sensory experiences, all of which can influence consumers' perceptions, judgments, and behaviours in virtual environments and enhance novel user

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experiences [3-4] to impact their purchase decisions. For instance, Volvo has launched a virtual test drive device to share car safety knowledge while providing users with an immersive VR experience. Samsung uses VR devices to assist individuals in overcoming their fear of heights or stage anxiety. Oreo employs 360-degree panoramic experiential advertising to give consumers a firsthand look at the creation of new products. The Sheraton Hotel uses VR to provide prospective guests with a 'real' experience ahead of their stay, while the outdoor brand North Face uses VR technology to enable customers to experience polar outdoor scenes in-store. Given the increasing popularity of VR customer education for providing product knowledge, it is necessary to examine its communication effectiveness and underlying mechanisms.

Currently, an apparent 'high awareness, low practice' phenomenon prevails in the field of sustainable consumption. In other words, there is an obvious 'attitude-behavior gap' among sustainable consumers [5-6]. Many consumers do not translate their pro-environmental awareness into actual sustainable consumption behaviour. According to previous research, consumers' lack of sustainable knowledge is the main impediment to the transformation of sustainable consumption behaviour [7]. Customer education is essential for enhancing consumers' knowledge of sustainable consumption. Prior research has shown that customer education can eliminate barriers and provide drivers for sustainable consumption behavior [8-10]. Sari et al. (2020) have found that customer education can raise customers' environmental concerns and affect their attitudes towards green products[11]. Zhou et al. (2021) have also indicated that customer education directly results in more consumers purchasing sustainable products [12]. However, these studies have failed to examine the processes involved in the effect of customer education on sustainable purchase intention. Additionally, they have focused only on traditional educational modes, such as eco-labelling, in-store face-to-face training, and video education. For example, Sundaraja et al. (2022) have revealed that interactive websites and promotional educational videos can increase consumers' willingness to purchase sustainable palm oil products [13]. Whether VR customer education is effective in increasing consumers' sustainable product knowledge and purchase intentions has not yet been investigated.

To fill this gap, this study first contributes to introducing modern VR technology into the current literature on customer education. VR also plays a positive role in raising awareness and changing attitudes towards environmental issues such as global warming, climate change or ocean acidification. Recent research has suggested that VR technologies can provide multisensory stimuli, drive sustainable consumption choices, and lead to prosocial behaviour among consumers in digital environments [14]. However, there has been little academic research on how consumers interact with VR technology [15] and the mechanism of the impact of VR on green consumption behaviour has not yet been tested [16].

Second, this study contributes to revealing the underlying mechanism of the effect of VR customer education on the level of sustainable knowledge by identifying the attributes of VR technology pertaining to sustainable knowledge education. By combining VR customer education with the self-determination theory, we posit that knowledge richness and usefulness are two relevant mediators involved in the processes of VR customer education. Specifically, for customers with intrinsic learning motivation, VR customer education has a positive effect on their level of sustainable knowledge through knowledge richness perception. Conversely, for customers with extrinsic learning motivation, VR customer education has a positive effect on their level of sustainable knowledge through knowledge usefulness perception. Moreover, this study contributes to the literature by considering the boundary conditions of the effect of VR customer education. Factors such as customers' prior sustainable product knowledge level play an important role in influencing consumers' green behaviour and decisions [17-18]; however, few studies have examined how this factor affects the effectiveness of using VR technology in customer sustainability education and its influence on consumers' sustainable purchase intention.

The remainder of this study is organised as follows. The second section presents a literature review and research hypothesis formulation, including VR-based education's characteristics, prior sustainable product knowledge levels, sustainable purchase intentions, and other topics, as well as the derivation of the relationship between variables. The third section describes the research methodology, including scale development and design. The fourth sections contains data analysis and hypothesis testing, including reliability and validity. The fifth section comprises the conclusion.

Review of Literature and Conceptual Framework

VR Education

VR technology, also referred to as 'immersive multimedia' or 'spirit boundary technology', combines data from the actual world with computer simulations to simulate an environment. By replicating authentic situations and human-computer interaction, VR technology provides users with multidimensional sensory stimulation, maximising their sensory-motor illusion, and significantly augmenting their sense of immersion. In recent years, VR has been used in numerous educational contexts, including intelligent educational product design, game-based learning, construction of smart learning environments, special education, and creator education. Most academics

and business organisations have investigated the application of VR in education and compiled numerous cases, primarily in knowledge education, skills training, and activity efficiency. Previous research has shown that VR education involves a high level of immersion, multidimensional interaction, contextual visibility, and scenario conceptualisation.

VR education, a new multimodal way to teach IT, stimulates the minds of learners and improves their thinking ability by creating virtual scenarios. Learners' perceptual organs are stimulated in a virtual interactive environment, but they do not immediately notice an improvement in learning impact. Instead, they consider the change in the interaction results after comparing them with previous experiences. If learners correct their inaccurate previous knowledge, thorough reflection and summarisation will eventually lead to improved perceptual learning [19]. Considering that VR is a new way for people to learn about the world and experience their surroundings, its immersive attributes encourage designers to focus more on enhancing the richness of the VR narrative and scene. Panoramic VR delivers immersive audiovisuals that inherently demand more detailed, comprehensive, and richer information to completely immerse users in the VR experience. In recent years, VR technology has emerged as a new instructional tool for promoting educational growth. VR education can help learners create a vivid learning environment that enables them to improve their memories, piques their interest in learning, and helps them engage in independent learning as opposed to passively absorbing information. This learning method contradicts traditional education, which merely imparts knowledge to learners. Some scholars have included reflective and personal engagement components in topic training to improve learning outcomes [20-22]. VR immersive education is an essential part of long-term education for users because it can enhance the information-input strategies used in traditional classrooms, allowing learners to gain access to more audiovisual resources. This improves their learning experience and they can easily absorb information and comprehend key concepts [23]. This study concludes by arguing that if customers are exposed to rich product knowledge or pertinent information in a VR environment, they are more likely to develop sustainable product knowledge as a result of multidimensional sensory stimulation.

Self-Determination Motivation Theory

According to the self-determination theory, motivation can be divided into intrinsic and extrinsic motivation based on the degree of self-determination [24-25]. Keaveney (1992) has defined intrinsic motivation as 'an individual's feeling of challenge or competence derived from performing a job' [26]. However, when the learning motivation of customers is intrinsic (as opposed to extrinsic), VR customer education has a stronger impact on enhancing knowledge of sustainable products and a more significant influence on sustainable purchase intention. Previous studies have confirmed the close link between motivation types and consumer attitude [27-30].

Regarding VR experiences, the features of VR systems could enhance learners' problem-solving capacity [31]. Virtual environments can be used to simulate creative work [32]. Creative outcomes can be induced through exposure to visual media, such as advertising [33], in-store displays [34], 3D video games [35], and immersive technology experiences [36-37]. When learners are motivated by intrinsic sources (e.g. personal interest, thirst for knowledge and curiosity), they adopt a divergent mode of thinking. Accordingly, they instinctively explore the problem from different perspectives, gathering a variety of evidence and materials and focusing on the breadth and diversity of information [38]. Previous studies have shown that people engage in volitional action for two different reasons to pursue intrinsic satisfaction, such as personal interest, and extrinsic contingencies, such as a promised reward [39-41]. When learners' learning motivation originates from obtaining rewards, they pursue quicker ways to obtain rewards and pay more attention to useful information to solve problems during the learning process [42]; for example, sustainable products have lower carbon than unsustainable products.

However, compared to the intrinsic learning motivation (ILM) group, extrinsic learning motivation groups tend to ignore the background knowledge on sustainable products, such as market knowledge of sustainable products, relationship between society and the economy, and challenges overcome in the production process [42]. Thus, their knowledge of sustainable products was incomprehensive. In addition, extrinsic motivation often weakens learners' intrinsic motivation and reduces learning outcomes due to the 'crowding-out effect' [43]. As suggested by cognitive evaluation theory, emphasis on extrinsic incentives lowers the level of intrinsic incentives. Extrinsic incentives influence intrinsic incentives because individuals perceive loss of control over their personal behaviour (voluntary behaviour is turned into controlled behaviour) or their esteemed values are degraded by extrinsic incentives. Thus, some clients protect the environment because of their personal environmental consciousness and green value. However, when small discounts (1 USD) are designed as incentives, clients refuse them [44]. Therefore, this study argues that when the customer's learning motivation originates from intrinsic (vs. extrinsic), VR customer education has a stronger effect on improving sustainable product knowledge levels when customers' learning motivation originates from intrinsic rather than extrinsic factors. Therefore, this study believes that VR customer education can improve customers' knowledge of sustainable products, but that participants with different learning motivations differ significantly. Thus, the following hypotheses are developed:

H1: VR customer education has a more positive effect on the sustainable product knowledge level of customers with intrinsic learning motivation than on that of customers with extrinsic learning motivation.

The Mediating Role of Knowledge Richness and Knowledge Usefulness

Extrinsic motivation is defined as doing something because one believes that it will help one achieve desired goals independent of the action itself. People are considered intrinsically motivated when they participate in an activity for reasons other than participation. Thus, perceived enjoyment is a type of intrinsic motivation, whereas perceived usefulness is a type of extrinsic motivation [45].

A defining feature of VR customer education is a high knowledge richness perception (KRP), such as the multidimensional introduction of product knowledge. VR (VR) is a promising technology for creating highly immersive and multisensory customer experiences [46]. VR stimulates individuals by providing differentiated content while maximising user immersion, presence, and experience satisfaction by presenting vivid and realistic information [47-50]. In various retail settings, VR is used as a shopping tool to deliver product information with vibrant imagery and interactive cues and as a new medium to stimulate consumers' imagination through sensory information. Expanding sensory experiences through content consumption is expected to stimulate consumers' curiosity and creative thinking. VR customer education can vividly and comprehensively demonstrate the production process and environmental impact of 3D animations. Customers can also learn about raw product materials and other detailed information through the VR 720° disassembly displays. VR experiences may reduce cognitive load and stimulate imagination, assisting the mind's capacity to conceptualise [50]. The knowledge richness of VR customer education fits well with the divergent thinking mode initiated by customers, and is driven by intrinsic motivation. For instance, based on the AISAS model, Lee et al. (2021) demonstrated the effects of the VR quality (vividness and interactivity) on customers' perceived media richness [51]. Therefore, VR customer education can promote a multidimensional and comprehensive understanding of sustainable product knowledge. Accordingly, we propose the following hypothesis:

H2: VR customer education positively affects customers' sustainable product knowledge level of customers with intrinsic learning motivation through knowledge richness perceptions.

Simultaneously, VR customer education is characterised by the perception of knowledge usefulness (KUP). For example, to address how products can reduce their impact on the environment, VR customer education, which simulates real situations and compares the different environmental impacts of unsustainable and sustainable products, can make customers fully aware of the value of sustainable products. The usefulness of VR customer education knowledge is in line with the convergent thinking mode initiated by customers driven by extrinsic motivation. This can promote customers' understanding of the advantages of sustainable products and consequently improve their cognition of the sustainable product knowledge level. In fact, when learners are motivated by extrinsic sources (e.g. reward or punishment), they follow a convergent thinking mode and tend to analyse and solve problems from a narrower perspective, focusing on directly gathering useful information related to the problem and often ignoring marginalised background knowledge [42]. Therefore, we propose the following hypothesis:

H3: VR customer education positively affects the sustainable product knowledge level of customers with extrinsic learning motivation through knowledge usefulness perception.

Sustainable Product Knowledge Level and Sustainable Purchase Intention

When consumers are made aware of environmental issues, their knowledge is likely to alter their environmental attitude. A KAP survey suggests that knowledge influences attitude and that knowledge and attitude comprise the foundations of practice [52]. Furthermore, some scholars have suggested that consumers' purchase decisions usually depend on their attitude towards the environment [53]. Attitude is an individual's view and acceptance of a behaviour, which, to some extent, determines whether the individual will engage in such behaviour. In fact, an increasing number of consumers are concerned about the environment and perceive that they are responsible for it. Accordingly, they are purchasing products that have less impact on the environment [54-55]. In their study on green consumers' purchases of technological products in the UK, Young et al. (2010) have suggested that many consumers try hard to change their purchasing attitudes because of environmental concerns [54]. Individuals' concern regarding their natural environment reflects their values and affects their behaviour [55]. Laroche et al. (2001) have stated that consumers' environmental attitudes strongly influence their intention to purchase green products [57]. In a study on the hotel industry, environmental consciousness was found to positively influence green consumption [58]. Moreover, Geng et al. (2016) have asserted that the public's limited understanding of such concepts prevents them from participating in the efforts to achieve sustainable development [59]. The public may be confused as to how sustainable consumption benefits the environment. Previous research supports this conclusion. For instance, Yadav and Pathak (2016) have discovered that younger consumers' environmental knowledge has a substantial positive effect on their environmental attitude [60]. Taufique et al. (2017) have reported that consumers' general environmental knowledge has an important

effect on their environmental attitude [61]. This study argues that improving customers' sustainability knowledge significantly affects their sustainable product purchase intentions. Therefore, VR consumer education improves comprehension of sustainable consumption, raises sustainability awareness, and increases the intention to make sustainable purchases. Therefore, we propose the following hypothesis: H4 Customer knowledge of sustainable products positively affects sustainable product purchase intentions.

The Moderating Role of Prior Sustainable Product Knowledge Level

Customers' prior knowledge refers to their understanding and subjective experience of a particular topic before being exposed to new information. Customers with high levels of prior knowledge are professional customers, otherwise, they are novice customers [62-63]. As early as the 1960s, Ausubel claimed that 'the most important single factor influencing learning is what the learner knows already' [64]. Therefore, if customers already have in-depth knowledge of sustainable products (i.e. professional customers), they are less likely to acquire new knowledge from VR customer education [65]. Instead, prior knowledge is particularly beneficial for novice customers, beginners' willingness to learn, and their speed of learning. VR customer education enables customers to have a better consumer experience, relieves their doubts, and provides them with new knowledge. Thus, regardless of whether professional customers are driven by extrinsic or intrinsic learning motivations, VR customer education is relatively limited to sustainable knowledge. Novice customers driven by intrinsic learning motivation have higher learning autonomy and excellent incremental, sustainable product knowledge than those driven by extrinsic motivation. It has been argued that customers' prior sustainability knowledge levels moderate this effect. The higher the level of customers' prior sustainable knowledge, the smaller the influence of learning motivation on the effect of VR customer education. Therefore, the following hypotheses are proposed in this study:

H5: When customers' prior sustainable product knowledge levels are high, the differences between the sustainable product knowledge levels of customers with different learning motivations are insignificant.

H6: When customers' prior sustainable product knowledge level is low, the increase in their sustainable product knowledge in the intrinsic learning motivation group is more significant than that in the extrinsic learning motivation group.

Based on the aforementioned analysis, we present the framework diagram of this study in Fig. 1.

Material and Methods

Scale and Questionnaire Design

This study uses a seven-point Likert scale to measure the following five variables: prior sustainable product knowledge level, knowledge richness perception, knowledge usefulness perception, sustainable product knowledge level, and sustainable purchase intention. The measurement questions for each variable were slightly modified based on previously established scales and combined with the stimuli used in this experiment. Table 1 presents the specific measurement questions.

Sample and Data Collection

According to McNeill and Venter (2019), the apparel industry is a major contributor of numerous social and environmental issues [66]. It results in 10% of the world's carbon emissions, making it the second most polluting industry worldwide [67]. Simultaneously, the demand for green clothing has increased, as evidenced by a shift in environmental knowledge, consumer beliefs, and attitudes [68]. To investigate the mechanism of VR knowledge education on customers' sustainable purchase intention, this study adopts a quantitative approach to explore customers' cognitive processes and learning effects in a VR environment. For this purpose, we use 3D jeans production process video education as experimental materials.

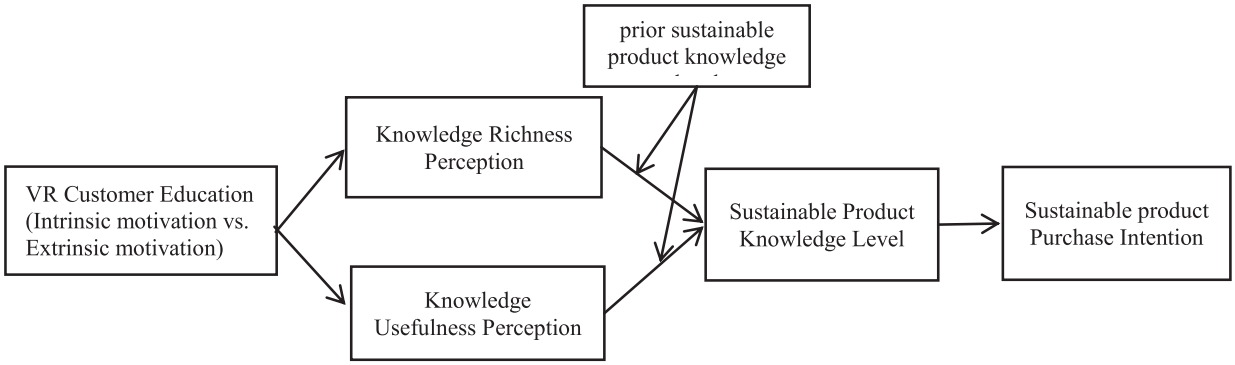

Fig. 1. Conceptual framework.

Table 1. Measurement items and constructs.

Dimensions	Items	Theoretical Support
Prior Sustainable Product Knowledge Level (PSPKL)	I know the ingredients and the process of making the clothing I buy (e.g., organic cotton, printing, and dyeing processes).	Kang et al., (2013)
	I know more about clothing recycling than the average person.	
	I know where I can find products with less waste.	
	I am aware of the sustainable environmental logos used on product packaging.	
	I am very knowledgeable about environmental and social issues in the textile and apparel industry.	
Knowledge Usefulness Perception (KUP)	The VR content helped me to gain new knowledge and perspectives on environmental pollution from jeans.	Jahmani et al.; Chung-Ho Su
	The VR content was helpful for me to learn information about environmental pollution caused by jeans products.	
	The VR content has given me a deeper and more intuitive understanding of environmental pollution from jeans.	
	I think it is a good choice for environmental education through a similar VR situation.	
Knowledge Richness Perception (KRP)	The VR content presents information about environmental pollution by jeans that are easy to understand	Ye L et al., 2012
	The VR content presents information about jeans products polluting the environment that is relatively accurate.	
	I think the information presented in the VR scene about jeans polluting the environment is more informative.	
Sustainable Product Knowledge Level (SPKL)	I have a clear understanding of the process by which jeans pollute the environment.	Kang et al., (2013)
	I have a clear understanding that jeans contain chemicals that pollute the environment.	
	I have become very familiar with jeans polluting the environment.	
Sustainable Product Purchase Intention (SPPI)	When I shop in the future, I will try to reduce the number of products that pollute the environment, such as jeans.	Zhang W., Liu L., 2022; Kong H. et al., 2016
	When shopping in the future, I will pay more attention to choosing products that are environmentally friendly.	
	I prefer to buy sustainable products, even if they are more expensive than other products.	
	When I shop in the future, I will look for environmental and fair-trade labels before buying products.	

To facilitate the study in a virtual laboratory, 174 college students from two universities in Wuhan were recruited. Prior to the formal experiment, participants were required to take a sustainable knowledge level scale test and answer the learning motivation for participating in this study. They were then divided into intrinsic and extrinsic motivation groups according to different learning motivations. Next, the participants donned VR headsets in accordance with the experimental requirements and clicked on them to begin VR learning. Following the completion of the 3D video, the participants were required to evaluate their perceptions of VR knowledge richness and usefulness. Participants' levels of sustainable product knowledge and purchase intentions were also measured.

A total of 174 questionnaires were collected for this experiment, among which 158 were valid. In this study, learning motivation was classified according to the self-reported measure scores of learning motivation. The final samples used for the subsequent data analysis were as follows: 80 people from the intrinsic learning motivation group accounted for 50.6% of the participants and 78 people from the extrinsic learning motivation group accounted for the rest. Regarding the gender of the participants, 60.75% were female and 39.25% were male. Additionally, the survey results showed that 63.92% spent less than $500 per month on clothing, 26.58% spent between $500 and $1,000, and 9.5% spent more than $1,000.

Analysis

Data analysis was conducted using SPSS24.0 software. First, the overall reliability and validity of the 158 valid questionnaires were analysed. ANOVA was used to test the effect of sustainable product knowledge level enhancement under different learning motivations. The bootstrap method was used to test the mediating effect. Finally, the moderating effect of a priori sustainable knowledge level was analysed.

Table 2. Cronbach's α coefficients of all variables in the Scale.

Variables	Item Quantity	Cronbach α
Prior Sustainable Knowledge Level	5	0.884
Knowledge Usefulness Perception	4	0.932
Knowledge Richness Perception	3	0.918
Sustainable Product Knowledge Level	4	0.918
Sustainable Purchase Intention	4	0.907

Results and Discussion

Reliability and Validity Analysis

A reliability test was conducted to verify whether the questionnaire results were consistent. A commonly used test method is Cronbach's α coefficient test. The higher the Cronbach' s α coefficient, the better the consistency of the questionnaire. Generally, the reliability of the scale with a Cronbach's α coefficient is greater than 0.8, indicating good reliability. According to our results, the Cronbach's α coefficient for all indicators of the questionnaire was greater than 0.85, indicating that the questionnaire had good reliability and consistency.

A validity test was conducted to verify the reliability and stability of the questionnaire, and the recovered data were used to confirm the validity of the questionnaire. Convergence validity tests in structural validity tests require all standardised factor load coefficients to be greater than 0.5, the composite reliability (CR) to be greater than 0.7, and Average Variance Extracted (AVE) to be greater than 0.5. To ensure the questionnaire validity these potential dimensions were analysed. It was found that the CR was greater than 0.7 and AVE was greater than 0.5, as shown in Table 3, indicating that the scale had good convergent validity.

In the discriminant validity of the structural validity test, the judgment criterion is that the square root of the AVE of each variable should be greater than the correlation coefficient between the variable and other variables. Table 4 presents the results of the study. Accordingly, this scale had good discriminant validity. The aforementioned test results showed that the optimised scale had good reliability and validity (including convergent and discriminant validity), with a total of 20 valid test items. Therefore, we could further study the relationships between the variables.

Hypothesis Testing Results

Through the construction of the conceptual model and research hypotheses proposed in this study, the hypothesised relationships were analysed using SPSS 22.0. First, an independent t-test was conducted using SPSS22.0 to test H1. The results showed that the intrinsic learning motivation group had a higher level of sustainable knowledge (M = 5.41, SD = 1.03) than the extrinsic learning motivation group (M = 4.98, SD = 1.02; t = -2.628, $p < 0.01$), supporting H1.

This study analysed the mediating roles of perceived knowledge richness and usefulness through bootstrapping [69]. Bias-corrected bootstrap analysis was conducted to test indirect effects. Following the recommendations of Preacher and Hayes (2008), the study rendered repeated extractions of a bootstrapped sample of 5,000 from the data to scrutinise the significance of the estimates with the associated 95% CI [70].

The indirect effect of intrinsic learning motivation on sustainable product knowledge level (SPKL) through knowledge richness perception (KRP) was significant (β = 0.229, SE = 0.055; 95%CI = [-0.297; -0.083], F (2,155) = 85.453, $p<0.01$). The indirect effect of extrinsic learning motivation on sustainable purchase intention through KUP and SPKL was also significant (β = 0.401, SE = 0.053; 95% CI = [0.087; 0.294], F (2,155) = 75.278, $p<0.01$). The results are summarised in Table 5.

Thus, H2 and H3 were supported. These results suggest that KRP/KUP mediate the effect of learning motivation on the level of sustainable product knowledge. When customers are educated (regardless of their learning motivation) using VR, they are influenced by the perception of knowledge richness or usefulness and obtain a higher level of sustainable product knowledge.

This study tested H4 through linear regression analysis, and the results showed that SPI = 1.269 + 0.724*SPKL, which means that customer knowledge of sustainable products must have an influential relationship with sustainable purchase intention ($F = 146.938$, $p = 0.000<0.05$). The final specific analysis shows that the value of the regression coefficient for SPKL is 0.724 (t = 12.122, $p = 0.000<0.01$), which means that sustainable product knowledge level has a significantly positive influence on sustainable purchase intention. Therefore, H4 is supported.

Finally, this study tested the moderating effect of customers' prior sustainability knowledge levels. The participants were assigned to high or low PSKL groups according to their median (3.986) through a 2 (intrinsic learning motivation vs. extrinsic learning motivation) and ×2 (high PSKL vs. low PSKL) grouping. A simple effects analysis was conducted. As shown in Fig. 2, for individuals with high PSKL, learning motivation had no significant impact on sustainable product knowledge levels ($M_{intrinsic}$ = 5.82, SD = 0.94; $M_{extrinsic}$ = 5.77, SD = 0.91; F = 0.019, $p>0.05$), supporting H5. For individuals with low PSKL, different learning motivations had a significant impact on sustainable product knowledge levels ($M_{intrinsic}$ = 4.8, SD = 0.67; $M_{extrinsic}$ = 4.43, SD = 0.47; F = 7.174, $p<0.01$). Therefore, H6 is supported.

Table 3. Results of convergence validity analysis of the scale.

Factor	Items	Load Factor	CR	AVE	Square Root of AVE
Prior Sustainable product Knowledge Level	PSPKL1	0.764	0.889	0.617	0.785
	PSPKL2	0.847			
	PSPKL3	0.771			
	PSPKL4	0.663			
	PSPKL5	0.865			
Knowledge Usefulness Perception	KUP1	0.891	0.935	0.784	0.885
	KUP2	0.944			
	KUP3	0.881			
	KUP4	0.822			
Knowledge Richness Perception	KRP1	0.903	0.919	0.792	0.89
	KRP2	0.915			
	KRP3	0.85			
Sustainable Product Knowledge Level	SPKL1	0.903	0.921	0.744	0.863
	SPKL2	0.861			
	SPKL3	0.889			
	SPKL4	0.794			
Sustainable Product Purchase Intention	SPPI1	0.786	0.909	0.715	0.845
	SPPI2	0.811			
	SPPI3	0.882			
	SPPI4	0.898			

Table 4. The results of discriminant validity analysis of the scale.

	PSPKL	KUP	KRP	SPKL	SPPI
PSPKL	0.785				
KUP	0.225	0.885			
KRP	0.208	0.868	0.89		
SPKL	0.395	0.702	0.724	0.863	
SPPI	0.441	0.59	0.598	0.696	0.845

According to the aforementioned analysis, all the hypotheses proposed in this study are supported. Specifically, the following conclusions can be drawn. In the context of VR customer education, intrinsic learning-motivated customers have better enhancement effects on sustainable product knowledge than the extrinsic learning group. Additionally, participants with intrinsic learning motivation focused more on the richness of their learning content. Conversely, participants with extrinsic learning motivation focused more on the usefulness of the learning content. VR customer education can improve consumers' sustainable knowledge levels, which can positively impact their sustainable purchase intentions. Finally, for customers with a low prior sustainability knowledge level, the learning effect of intrinsically motivated customers was better than that of the extrinsically motivated group. These findings have valuable implications for sustainable brands and corporate managers dealing with the use of VR technology to educate customers.

This study's theoretical contributions are based on the following developments. First, previous research has focused on demonstrating that VR education is better than traditional education; however, we propose and examine the underlying mechanism of VR customer knowledge education on sustainable purchase intention, which greatly enriches the research on VR in the field of customer education. Second, this study combines the self-determination theory with VR customer education to investigate the learning effects of participants with different learning motivations and expand the scope of customer education research.

Additionally, this study contributes to the management of sustainable businesses. First, most businesses remain in the traditional stage of customer education, which is insufficiently immersive and lacks a tangible sense of expertise. Sustainable businesses can quickly provide novel experiences to customers, convey

Table 5. Indirect effect analysis.

Path	Effect	Boot SE	BootLLCI	BootULCI	t-value	p	Results
ELM→KUP→SPKL	0.401	0.053	0.087	0.294	7.632	0	supported
ILM→KRP→SPKL	-0.396	0.055	-0.297	-0.083	-7.168	0	supported

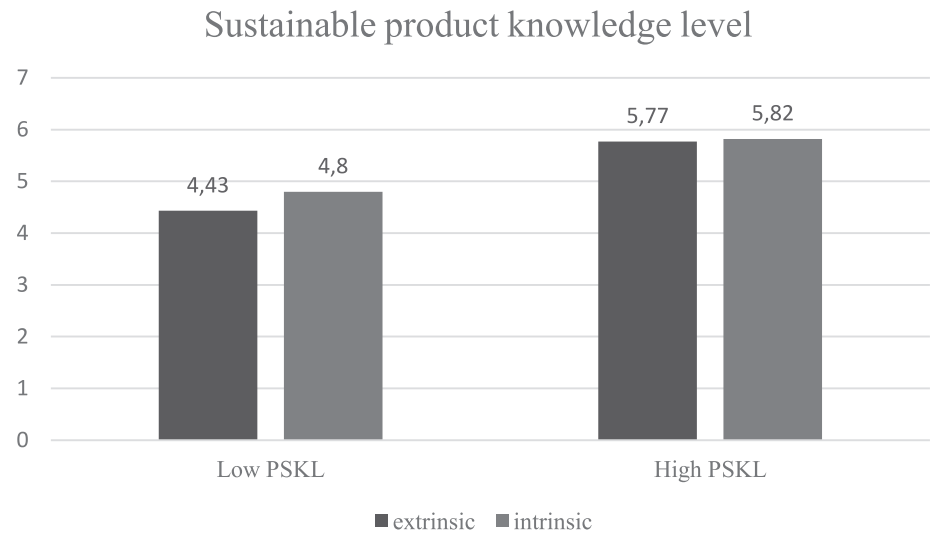

Fig. 2. The moderating role of the prior sustainable product knowledge level (PSPKL).

rich information, improve the knowledge of potential customers, and realise the value of enterprises for sustainable development if they actively use innovative technologies, adopt VR methods, and combine the characteristics of their products. Furthermore, VR customer knowledge education is more effective for customers with lower levels of sustainability knowledge. Therefore, businesses should conduct targeted education for various customer types, and sustainable brands should consider the needs of various customer types when designing VR customer education programs to achieve better learning outcomes. For example, a U.S.-based company called TOMS and VRSE (now called Within) worked together to create the VR experience 'A Walk in Their Shoes,', which used VR as a medium to allow viewers to truly experience the brand's mission, instead of just promoting and informing it to them. TOMS is a company with a mission to protect the environment and do good. Wearing a headset, the VR users VR experienced 'Trailscape' and were instantly 'transported' to the Italian Dolomites to experience the thrill and fun of mountain climbing. The VR experience was developed by the outdoor clothing company Merrell in partnership with Framestore, a gold-medal-winning special-effects studio. By highlighting the attributes and benefits of the product or service, the experience was placed in the context of the lifestyle or experience that the product or service can facilitate. Meanwhile, major corporations such as Nike and Coca-Cola have recently made significant investments in virtual marketplaces and meta-markets to motivate the use of VR head-mounted displays and VR experiences designed to reinvent the consumer experience [71]. This promotes brand loyalty and product understanding. Finally, sustainability companies should strive to motivate prospective customers to learn intrinsically and conduct VR customer education to emphasise the usefulness of educational content. This is because usefulness promotes recognition and sustainable knowledge leads to improved educational outcomes.

Conclusions

Recent research suggests that VR has a positive impact on raising environmental awareness and changing attitudes. This study investigates how customer's VR -related education can improve consumers' sustainable knowledge, which can subsequently their willingness to make sustainable purchases and promote sustainable consumption. In this study, we propose a research framework for VR customer knowledge education based on the self-determination motivation theory. The results of this study indicate the importance of making the most of the richness and usefulness of VR content. Understanding the learning motivation of different customers is crucial for enhancing the effectiveness of VR education. Additionally, this study confirms that customer education has a positive effect on promoting sustainable product purchase intentions, which is consistent with the findings of previous studies.

To the best of our knowledge, no quantitative research has been conducted on customer education in the context of VR. Although this study provides an insightful perspective into the application of VR in customer education, it has several limitations. First, it did not investigate consumers' actual sustainable consumption behaviours. Although intention is widely regarded as a direct predictor of actual behaviour, it does not always result in actual action [72]. Further studies can design and measure the actual consumer behaviour after completing the VR education course, instead of solely using self-reported intention. Second, the research framework includes only the variables of knowledge richness and usefulness, level of sustainable product knowledge, and learning motivation; accordingly, other VR attributes, such as perceived interactivity and immersion are neglected. These aspects can be considered within the same context to enhance the persuasiveness of VR customer education. Third, we employed a laboratory experiment to gather samples from undergraduate students in China. Therefore, future research should be conducted in retail stores to increase the representativeness of the results, making it possible to obtain an in-depth comprehension of VR customer education.

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Conflict of Interest

The authors declare no conflict of interest.

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