

Construction and Empirical Analysis of Citizens' Water Literacy Evaluation Index System: A Structural Equation Model

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Research Article

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Abstract

This study draws on the existing water literacy evaluation system and the weight of each indicator to construct a three-dimensional theoretical analysis framework of water knowledge, water attitude, and water behaviour. Based on the constructed evaluation index system, research hypotheses were proposed, questionnaires designed, and areas of Beijing, Zhengzhou, Hechi, Qingtongxia selected for investigation. According to the constructed structural equation model of citizen water literacy, the influence degree of the influence factors of citizen water literacy evaluation on the path is discussed. The coefficient of the influence degree of each factor on water literacy is obtained. The research results show that: 1) water knowledge has a positive and significant influence on water attitude; 2) water attitude has a positive and significant impact on water behaviour; 3) water behaviour has a positive and significant impact on water literacy. 4) The following two hypotheses, that water knowledge has a positive and significant effect on water behaviour, and water attitude has a positive and significant effect on water literacy, are shown not to hold. The research conclusions can provide a theoretical basis for the water sector to formulate relevant policies to improve water literacy.

1 Introduction

Water resources are the foundation of social development and essential for economic development. As the population grows, household water consumption is expected to increase by 130% by 2050 (OECD 2012). Industrialisation, urbanisation, and irrigation have increasingly demanded water well as the uneven distribution of water resources, water pollution, and water ecosystem imbalance have exacerbated the current contradiction between water supply and demand. The global water crisis has become more prominent and has gradually become a severe constraint on global economic development. Some studies have shown that water sustainability must be based on explicit knowledge and understanding of our water resources and their relationship with humans and global systems (McCarroll and Hamann 2020). In addition, the demand for such knowledge is not limited to water managers, researchers, and decision-makers but also includes every citizen and water user. Scholars advocate environmental activities to mobilise a wide range of public support and actions, even those who "may not consider themselves environmentalists" (Bergquist et al. 2020). "Do a good job of popularising science and focusing on improving the water literacy of the whole people" also requires the broad understanding and participation of the public. The water sector should carry out extensive and in-depth water science popularisation activities to create an intense atmosphere for scientific water use and a good habit of "saving water, loving the water and protecting water".

With the increasing awareness of the importance of water emerged the field of "water literacy". It is the culmination of knowledge, attitudes, and behaviours related to water, distinguishing its importance and uniqueness from other more commonly used labels such as ecological or environmental literacy. However, the research on water literacy is more about investigation and Publicity of water-related knowledge (Dean et al. 2016), attitudes towards water (Hao et al. 2010; Randolph and Troy 2008), and

water-saving behaviours or influencing factors of water-using behaviours (Clark and Finley 2007; Aisa and Larramona 2012) in a particular region, industry, or social group.

The concept of water literacy is a comprehensive quality related to water resources and the water ecological environment formed by people's gradual study and accumulation in production and life. It is the sum of necessary water knowledge, scientific water attitude, and standardised water behaviour (Wang et al. 2017). Water literacy should include variables such as water knowledge, attitude, and appropriate water behaviour (Middlestadt et al. 2001; Willis et al. 2011; McCarroll and Hamann 2020). Based on understanding the connotation and basic structure of water literacy, the research draws on the existing water literacy evaluation system and each index's weight. It constructs a three-dimensional theoretical analysis framework of water knowledge, attitude, and behaviour. A questionnaire based on the three-level indicators of the water literacy evaluation index system was designed, and surveys were conducted, and data were obtained in the four cities of Beijing, Zhengzhou, Hechi, and Qingtongxia in China. This study used Amos 21.0 to establish a structural equation model to conduct empirical research on water literacy evaluation indicators, explored the relationship between the influence factors of citizens' water literacy evaluation on the path, and obtained each factor's degree of influence coefficient on water literacy. The primary purpose is to verify the feasibility of the water literacy evaluation index system and questionnaire and to initially understand the primary status of citizens' water literacy. The research conclusions can provide a theoretical basis for the water sector to formulate relevant policies to improve water literacy.

2 Construction Of Water Literacy Evaluation Index System

The construction of the water literacy evaluation system involves many disciplines, and its academic and scientific nature needs to be widely recognised. Therefore, this study hopes to establish a general framework to evaluate water literacy level, distinguish its importance and uniqueness from other literacy (ecological or environmental literacy), and deepen the understanding of defining and applying water literacy. Research on water literacy has gradually entered the field of vision of researchers. However, the current research on water literacy only constructs an evaluation index system and designs a questionnaire based on the evaluation index system to obtain survey data to realise the evaluation of the water literacy level of the surveyed. (He 2018; Tian et al. 2021). This study draws on the water literacy evaluation index system constructed by He (2018) and Tian et al. (2021) and explores the relationship between the evaluation indicators based on survey data. This study has identified three secondary indicators and their corresponding ten tertiary indicators. These indicators are defined according to the 29 most common themes. The difference from the index system for reference is that this study is based on selecting 29 three-level index factors and uses the method of document tracking to analyse the text of the searched references. These references clearly define or very clearly describe the meaning of these index factors, to improve the scientificity and rationality of the sources of water literacy evaluation indicators.

Table 1 visually shows all the indicators and the references corresponding to the 29 three-level indicators. Among them, the knowledge dimension includes three independent indicators: Basic knowledge of water science, knowledge of water resources development and utilisation and management, and knowledge of

water ecology and environmental protection. The water attitude dimension includes three independent indicators: water emotion, water responsibility and water ethics. The water behaviour dimension includes four independent indicators: water ecology and management behaviour, persuasive behaviour, consumer behaviour, and legal behaviour. The Analytic Hierarchy Process determines the weight of water knowledge, water attitude, and water behaviour. The different weights of the three dimensions also reflect a common problem in the sustainable development of water resources: actual actions exceed knowledge cognition and emotional learning (Kals and Maes 2002). Citizens' water literacy evaluation index system and its weights can be used as the theoretical basis for designing water literacy survey questionnaires for sampling surveys.

Table 1

Citizens' water literacy evaluation index system weights, index sources and corresponding survey questions

First-grade index(weight)	Second-grade index(weight)	Third-grade index (weight)	Main reference	Corresponding questionnaire question	
Water knowledge (0.0914)	Basic Knowledge of water science (0.2763)	Knowledge of the physics and chemistry of the water (0.0370)	Project WET 2011, 2020	SZS1. Do you know the following basic knowledge of water science? A. Knowledge of the physics and chemistry of the water	
		Knowledge of water distribution (0.4350)	Pan and Liu 2018; Wang et al. 2019	B. Knowledge of water distribution	
		Water cycle knowledge (0.0535)	Al-Jayyousi 2004; Robertson 2021	C. Water cycle knowledge D. Knowledge of commodity properties of water E. Knowledge of water and life	
		Knowledge of commodity properties of water (0.1875)	Howe and Goemans 2002; Guerrero 2020		
		Knowledge of water and life (0.2870)	Hawke 2012; Project WET 2011, 2020)		
	Knowledge of water resources development, utilisation, and management (0.1273)	Knowledge of water resources development and utilisation (0.2)	Knowledge of water resources development and utilisation (0.2)	Kauzeni and Madulu 2001	SZS2. Do you know the following knowledge of water resources development, utilisation, and management? A. Knowledge of water resources development
			Knowledge of water resources management (0.8)	Mirzaei-Nodoushan et al. 2021; Dungumaro and Madulu 2003	B. Knowledge of water resources utilisation C. Laws and regulations, administrative regulations
					D. Water-saving technology, sewage treatment technology
					E. Publicity, education

First-grade index(weight)	Second grade index(weight)	Third-grade index (weight)	Main reference	Corresponding questionnaire question
	Knowledge of water ecological protection (0.5964)	The impact of human activities on the aquatic ecological environment (0.5083)	Su et al.	SZS3. Do you think the following some activities will impact the aquatic environment?
		Knowledge of water environment capacity (0.0555)	Ivey et al. 2006; Zhou et al. 2017	A. Direct discharge of wastewater from industrial production B. Direct discharge of domestic sewage C. Excessive use of pesticides, fertilisers, and other chemicals D. Destroy forests, wetlands, etc. that conserve soil and water
		Water pollution knowledge (0.2908)	Tran et al. 2002; McCarroll and Hamann 2020	E. Rapid consumption of water resources
		Knowledge and skills of water eco-environmental action strategies (0.1454)	Gillis 2013	SZS4. Do you know the following knowledge of water ecological environment protection? A. Knowledge of water environment capacity B. Water pollution knowledge C. Water conservation and protection knowledge D. Knowledge of water eco-environmental action strategies E. Skills of water eco-environmental action strategies
Water attitude (0.2176)	Water feelings (0.1047)	Water interest (0.3333)	Willis et al. 2011	STD1. Do you like places of interest or scenic spots related to water?
		Water attention (0.6667)	Gilg and Barr 2006; Craig and Garrett 2001; Willis et al. 2011	STD 2. Do you understand the current water problems in our country that need to be resolved?
	Water responsibility (0.6370)	Water-saving responsibility (0.6667)	Corral-Verdugo et al. 2002; Syme et al. 2004	STD 3. Are you willing to save water? STD4. Are you willing to reduce the quality of life to save water?

First-grade index(weight)	Second-grade index(weight)	Third-grade index (weight)	Main reference	Corresponding questionnaire question	
		water protection (0.3333)	Hurd 2006, Debnin.2020	STD5. Are you willing to take some actions (such as picking up rubbish by the water, not throwing rubbish in the water) to protect the water ecological environment?	
	Water ethics (0.2583)	Water ethics (0.6)	Laporte et al. 2020; Groenfeldt 2019	STD 6. "We contemporary people do not need to consider water shortage and water pollution problems, and future generations will have a way to solve them", what is your attitude toward this statement?	
		Water moral principles (0.4)	Gagné 2020	STD7. Do you agree with the statement "who pays for water and who pollutes compensates"?	
Water behaviour (0.6910)	Water ecology and water environment management behaviour (0.1201)	Participate in Publicity of water-saving and water protection (0.0882)	Wang et al. 2019	SXW1. Pay attention to public welfare activities, such as cherishing water resources and saving water advertisements.	
		Participate in the protection of ecological water environment (0.1569)		SXW 2. Proactively explain to others the importance of protecting water resources/encourage others to implement water resources protection behaviours	
		Proactive learning of water-saving skills (0.2717)		Campbell et al. 2004; Gilg et al. 2005	SXW 3. Actively accept water conservation and water protection publicity and education activities
		Proactive learning of disaster avoidance skills (0.4832)		Wang et al. 2019	SXW 4. Learn/understand the techniques and methods for avoiding water disasters (flash floods, urban waterlogging, mudslides, etc.)
		Participate in the prevention of water pollution events (0.8333)		Persuasion (0.0621)	SXW 5. Advise other organisations or individuals to stop sewage discharge, etc.

First-grade index(weight)	Second-grade index(weight)	Third-grade index (weight)	Main reference	Corresponding questionnaire question
		Participate in public affairs activities of environment-protection organisations (0.1667)		SXW 6. Participate in water conservation and water conservation activities organised by the community or work unit
	consuming behaviour (0.5751)	Production and domestic wastewater reuse behaviour (0.5396)	Wang et al. 2019; Ahmmadi et al. 2021	SXW 7. Use rice water to wash vegetables or water flowers, etc. SXW 8. Collect the rinsing water from the washing machine's dehydration or hand washing for reuse
		Domestic sewage recycling behaviour (0.2970)	Wang et al. 2019	SXW 9. After finding a large amount of water in the early stage, take the initiative to reduce the number of washing, hand washing or bathing
		Domestic water consumption (0.1634)	Wang et al. 2019; Jorgensen et al. 2009;	SXW 10. Purchase or use household water-saving equipment (such as water-saving toilets, water-saving faucets, water-saving irrigation equipment, etc.)
	Legal behaviour (0.2427)	Water-saving facilities Utility	Klein et al. 2007; Renwick and Green, 2000; Wang et al. 2019	SXW 11. Proactively comply with water-related laws and regulations
		Abide by the water-related laws and regulations (0.6250)		SXW 12. Actively discourage or stop when a person or organisation is found violating water-related laws and regulations
		Report or supervise water environment incidents (0.1365)	Wang et al. 2019	SXW 13. When an individual or organisation is found to discharge untreated sewage, report it to the relevant department
		Supervise the management effectiveness of the law enforcement department (0.2385)		SXW 14. When it is found that the water administrative supervision and law enforcement department is not acting, report to the relevant department

3 Questionnaire Design And Pilot City Survey

3.1 Questionnaire design

The survey content of water literacy includes the background information of the survey samples, understanding of water literacy, sources of water knowledge, citizens' attitudes toward the water, and citizens' water behaviours. The questionnaire design is based on the constructed indicator system, which quantitatively measures whether each sample has a high level of water literacy from three aspects: "necessary water knowledge", "scientific water attitude", and "standard water behaviour". The number of questions on water knowledge, water attitude, and water behaviour in the questionnaire is set according to the weight of each indicator. Considering the time and effort required by the respondents to complete the questionnaire, the main body of the questionnaire should not set too many questions (Patten 2016). Therefore, the questionnaire will include 4 water knowledge questions, 7 water attitude questions, and 14 water behaviour questions. The questionnaire is designed in the form of a Likert five-level scale. All the questions are shown in the last column of Table 1.

3.2 Survey objects and survey data acquisition

To fully and accurately understand the water literacy status of citizens, this survey mainly used four pilot cities in China, including Beijing, Zhengzhou in the central, Qingtongxia in the north, and Hechi in the south. The survey subjects included minors aged 6-17, government workers over 18, residents, enterprise workers, farmers, students, and other occupations. Based on the principles of scientificity and comparability, this survey adopts quota sampling. The first step is to classify the overall sample of the survey according to regional administrative signs and determine the sample size according to the total population of each region. Secondly, according to the urbanisation rate, the quotas are further allocated to the urban and rural areas, and finally, samples are randomly selected from each area. The specific questionnaire issuance and recovery are shown in Table 2.

Table 2
Questionnaire distribution and recovery

Pilot area	Beijing	Zhengzhou	Hechi	Qingtongxia	Total
Number of questionnaires issued	390	350	305	140	1185
Number of valid questionnaires	323	303	293	139	1058
Efficient questionnaire	82.81%	86.57%	96.06%	99.28%	88.4%

3. 3 Exploratory Factor Analysis

Before analysing the questionnaire survey data, we must first test the reliability and validity of the scale. This study uses SPSS21.0 to test the reliability and validity of the scale. The reliability test results show that the Cronbach's α coefficient of the total sample is 0.750, more significant than 0.7, indicating that the

overall citizen water literacy questionnaire has considerable reliability. The validity of the data was analysed by Kaiser-Meyer-Olkin (KMO) test and the Bartlett sphere test. The results showed that the KMO value was 0.818 and Sig.<0.05 (p value<0.05). Therefore, this questionnaire is suitable for factor analysis.

Anderson and Gerbing suggested that the model should be established through exploratory factor analysis in developing new theories. Its results provide an essential foundation and guarantee for confirmatory factor analysis to establish hypotheses. Both two-factor analyses are indispensable (Anderson and Gerbing 1988). In this paper, the principal component method is used as the factor analysis method, and the maximum variance method is used as the factor orthogonal axis method to obtain the reflection image correlation matrix. The diagonal coefficients in the matrix represent the measure of each variable's sampling adequacy (MSA). If the MSA is less than 0.5, the item is not suitable for factor analysis. From the reflection image correlation matrix, the minimum value of MSA in all items is 0.646, indicating that each indicator is suitable for factor analysis. The cumulative contribution rate of the common factors is 65.268%. Each item's load value on the common factor is more significant than 0.5, which shows that the factors retained after extraction are suitable, and the structural design among the questionnaire variables is reasonable.

4 Empirical Research On Citizen Water Literacy Evaluation Based On Structural Equation Model

4.1 Overview of Structural Equation Modeling

The structural equation model was proposed by Swedish statisticians Karl Joreskog and Dag Sordorm in the 1970s. It is an applied linear equation system that expresses the relationship between observed variables and latent variables and between latent variables. The structural equation model validates the relationship between the observed variable and the latent variable by combining path analysis and factor analysis, and finally obtains the overall effect, direct effect, and indirect effect between the independent and dependent variable (Jöreskog and Sörbom 1982). It is currently widely used in psychology, sociology, management, and other disciplines. The model equation is as follows:

$$Y = \gamma_Y \eta + \varepsilon$$

$$X = \gamma_X \xi + \sigma$$

$$\eta = B\eta + \tau\xi + \zeta$$

Where: Y is the vector composed of endogenous observation variables, X is the vector composed of exogenous observation variables, η is the internal latent variable, ξ is the exogenous latent variable, and γ_Y is the factor of the endogenous observation variable on the endogenous latent variable Load matrix, γ_X is the factor load matrix of the exogenous observation variable on the exogenous latent variable, ε

and σ are the measurement error matrix of the endogenous latent variable and the exogenous latent variable respectively. γ represents the mutual influence between the constituent factors of the endogenous latent variable η in the structural model, τ represents the influence of the exogenous latent variable ξ on the endogenous latent variable η , and ζ is the residual matrix.

This study uses Amos 21.0 to establish a structural equation model of the influencing factors of citizens' water literacy, discusses the influence factors of citizens' water literacy evaluation on the path, and obtains the degree of influence coefficient of each factor on water literacy. The structural equation model constructed in this study has apparent advantages for exploring the relationship between water literacy, a relatively novel concept of evaluation indicators. First, it can provide a conceptual modelling and verification process for many difficult-to-measure concepts involved in water literacy evaluation indicators. Secondly, by constructing a systematic structural equation model, all exogenous and endogenous variable information in the water literacy evaluation index system can be considered, and the measured variables are allowed to have errors. The conceptual model constructed on this basis has a substantial reference value. Third, it can simultaneously estimate the structure of indicators and the relationship between indicators and estimate the degree of fit of the entire model.

4.2 Building an initial conceptual model based on research hypotheses

4.2.1 Research hypothesis

Water knowledge and water attitude. Most scholars have confirmed the influence of knowledge on attitude. For the research on the influence of water knowledge on water attitude in China, specific research documents at home and abroad were used for reference. For example, in McCarroll and Hamann's (2020) review on water literacy, it is mentioned that the increase of water knowledge will arouse a strong sense of responsibility among citizens, and education on water knowledge can also change people's attitude towards water (Cockerill, 2010; Mullenbach and Green, 2018). This research draws on available, comprehensive research of the theoretical relationship between environmental knowledge and environmental attitude in environmental literacy. One belief is that environmental knowledge will lead to improving and changing environmental attitudes. Marcinkowski (1988) divides the individual's environmental knowledge into three categories: natural environmental knowledge, environmental action knowledge, and environmental problem knowledge, and believes that an individual's environmental knowledge can have a significant impact on their environmental awareness, sensitivity, and environmental attitude. Some scholars have studied the principles of forming citizens' environmental behaviours and reached the following hypothesis: residents' environmental knowledge has a significant positive impact on environmental attitudes. Moreover, a positive relationship between environmental knowledge and environmental attitudes has been repeatedly demonstrated in students and citizen groups (Yu 2010). In general, environmental attitudes can also affect the further acquisition and growth of environmental knowledge. Individuals will actively learn environmental knowledge with a specific positive

environmental attitude and apply it in practical actions. This increases the amount of environmental knowledge acquired during continuous learning, thereby improving personal environmental attitudes. Therefore, this study puts forward the hypothesis: water knowledge has a positive and significant influence on water attitude.

Water knowledge and water behaviour. Hynes et al. (1987) researched and concluded that environmental knowledge promotes environmental behaviour. Water knowledge can identify water-related problems and know how to solve these problems and act (Robelia and Murphy 2012; Dean et al. 2016). Education of water knowledge can enhance citizens' understanding of water and change people's behaviour (Cockerill 2010; Mullenbach and Green 2018). Studies in other fields have also proved that knowledge can promote behaviours. For example, through empirical research, Tanner and Kas (2010) proved that action-related knowledge could significantly predict individual green buying behaviour. Wang and Zhong (2016) tested various factors influencing residents' environmental behaviour through a nationwide telephone poll, and the results showed that environmental knowledge has a significant effect on environmental behaviour. Peng (2015) discussed the impact of urban residents' environmental cognition on environmental behaviour, and the results showed that urban residents with environmental protection knowledge implement environmental behaviours. Wang and Han (2016) analysed the impact of economic development and environmental pollution on public environmental protection behaviour based on data from the 2013 China Comprehensive Social Survey. They found that personal environmental protection knowledge positively impacts personal environmental protection behaviour. Based on the above analysis, this study proposes a research hypothesis: water knowledge positively influences water behaviour.

Water attitude and water behaviour. This research refers to the related research of planned behaviour theory, which believes that behaviour intention is the direct factor that determines behaviour and is affected by behaviour attitude and subjective norms (see Figure 1). Behavioural intention refers to the motivational factors that affect individual behaviour, indicating the degree to which the individual is willing to try a specific behaviour and make efforts. The stronger the behavioural intention, the greater the possibility of acting (Ajzen 1991). This model indirectly shows that behavioural attitude is positively correlated with environmental behaviour, but attitude is not the only factor that affects behaviour; it is also affected by perceptual behaviour control.

The ABC theory proposed by Guagnano et al. (1995) et al. pointed out that attitude variables affect behaviour and interact with external conditions to produce behaviour. When external conditions have no effect, attitude is the only factor that affects behaviour, and environmental attitude has the most decisive influence on environmental behaviour. When external conditions have a significant positive or negative impact, they may greatly promote or hinder the occurrence of environmental behaviours. At this time, the influence of environmental attitudes on environmental behaviours will become weaker. Some surveys found that water attitudes are related to water behaviours, and proper water attitudes tend to show better water behaviours (Attari 2014; Cheng 2011). Based on the above research conclusions, it is concluded that water attitude impacts water behaviour, which is one of the influencing factors on water behaviour. Even when external conditions such as water price, regional resource endowment, income level, and

education level have a significant effect, it will play a regulatory role to a certain extent. Therefore, this study puts forward the hypothesis: water attitude has a positive and significant influence on water behaviour.

According to the previous exploratory research on the connotation of water literacy and its influencing factors, water literacy is characterised by water knowledge, water attitude, and water behaviour. Thus, water knowledge, water attitude, and water behaviour positively and significantly impact water literacy.

4.2.2 Construction of the initial conceptual model

The model setting should put forward an initial theoretical hypothesis model based on theoretical analysis and previous research results, preliminarily draw up the equation set of the structural equation and set the fixed coefficients in the structural equation set accordingly. According to the indicator system constructed above, the secondary indicators include water knowledge, water attitude, and water behaviour, which can be used as latent variables and water literacy latent variables into the model as latent variables for constructing the model. After consultation with experts in related fields, the relationship between latent variables is set based on the proposed research hypothesis. The AMOS 21.0 software was used for multiple fitting and comparison of the model, and after two revisions, the initial conceptual model path diagram was finally determined, as shown in Figure 2.

4.3 Model fittest

The fitness index test tests the possibility of the fitness between the hypothetical path model diagram and the collected data. The better the fit, the higher the fit between the constructed model and the data, and the closer it is to the actual data. Many experts and scholars have their own opinions on model adaptation, and different adaptation index evaluations have different degrees of support for the model. Based on the diversification test criteria and the conceptual model constructed in this paper, this study mainly uses NC value (The ratio of chi-square to degrees of freedom, Chi-Square/df), significance P-value, GFI (Goodness-of-Fit Index) value, AGFI (Adjusted Goodness-of-Fit Index) value, IFI (Incremental Fit Index) value, CFI (Comparative Fit Index) value, and RMSEA (Root Mean Square Error of Approximation) value to test the fitness of the indicators and to judge whether the model meets the decision-making basis of the overall fitness.

This study tested the model's fit, and the data and model were gradually revised according to the test results. The revised results and the obtained index values of the fit are shown in Table 3. It can be seen from the table that after the second correction, except for the IFI value, which is slightly lower than the standard value, other adaptability indicators all reach the standard. It shows that the model has high adaptability and can prove the influence path and significance degree of various factors affecting water literacy.

Table 3
List of standard values and adaptation values of model adaptability indicators

Index	Model fit standard value	Model adaptation index value		
		Original model	After the first correction	After the second correction
NC	1<NC<3, NC>5 model repair needs to be corrected	3.21	3.01	2.16
GFI	>0.90	0.854	0.897	0.913
AGFI	>0.90	0.915	0.901	0.921
IFI	>0.90	0.843	0.855	0.864
CFI	>0.90	0.876	0.944	0.953
RMSEA	<0.05 Good adaptability, the smaller the value, the better	0.061	0.043	0.032

According to the questionnaire data in the pilot area, combined with the set initial conceptual model of water literacy influencing factors, a structural equation model of water literacy influencing factors is constructed, as shown in Figure 3. The variable in the ellipse in the figure represents the latent variable, the variable in the rectangle represents the observed variable, the one-way arrow represents the causal relationship, the two-way arrow represents the interaction between the two indicators, and e represents the error term of the observed variable. Observed variables need to reflect the variables to be measured based on each factor's load and significance level. The calculation result in the figure shows that the factor load of each observed variable is mostly between 0.6 and 0.9 and reaches a significant level.

Based on the hypothesis proposed in the previous article, the path coefficients of water knowledge to water attitude, water knowledge to water literacy, water attitude to water behaviour, and water behaviour to water literacy are 0.32(P<0.01), 0.58(P<0.01), 0.39(P<0.01), 0.39(P=0.008) respectively, indicating that the hypotheses are all valid. The influence path coefficient of water knowledge on water behaviour is 0.02, and the influence path coefficient of water attitude on water literacy is -0.01, but both influences are not significant (P>0.05). The hypothesis that water knowledge of the citizens of the pilot areas has a significant positive impact on water behaviour and water attitudes has a significant positive impact on water literacy does not hold.

5 Results Discussion

The path coefficient of water knowledge to water attitude is 0.32 (P<0.01), indicating that citizens' water knowledge significantly impacts water attitudes. The above conclusion coincides with the previous

definition of water literacy. Water attitude is a relatively stable personal quality formed by internalising water knowledge, resulting from accumulation and internalisation. It will lastingly affect citizens' behavioural awareness of the outside world and themselves. This also verifies that Fortner (1978), Sia (1985), Yu (2010), and others have obtained a positive correlation between environmental knowledge and environmental attitude through empirical verification.

The influence path coefficient of water attitude on water behaviour is 0.39 ($P < 0.01$), indicating that citizens' water attitude has a significant positive impact on water behaviour. This conclusion further validates the classic social psychology planning behaviour theory proposed by Ajzen (1991). The occurrence of behaviour is due to the generation of behaviour intention, and one of the important influencing factors of behaviour intention is the formation of attitude. It can be seen that positive water attitudes, unfortunately, promote people to produce positive water behaviour intentions and then form standardised water behaviours.

The path coefficient of water knowledge on water literacy is 0.58 ($P < 0.01$), indicating that citizens' water knowledge has a significant positive impact on water literacy, and the path coefficient of water behaviour on water literacy is 0.39 ($P = 0.008$), indicating that water behaviour also has a significant favourable influence on water literacy. Based on the above analysis of water literacy, water literacy is the sum of scientific water knowledge, scientific water attitude, and standardised water behaviour. Therefore, the model also verifies the two dimensions of water literacy. Based on the connotation of environmental literacy, related research on environmental literacy evaluation, and the research conclusions of other scholars, the Environmental Literacy Assessment Consortium composed of literacy experts (e.g. Hungerford H, Volk T, Wilke R, Champeau R, Marcinkowski T) forward the four dimensions of the environmental literacy evaluation framework (Simmons and Koenig 1995; Wilke and Lee 1995; Erdogan and Ok 2011). These are (1) Cognition (knowledge and skills), (2) Emotion, (3) Other factors that determine responsible environmental behaviour, (4) Individual and collective participation in responsible environmental behaviour. This framework identifies three basic categories: environmental knowledge, environmental awareness, and environmental behaviour.

However, the path coefficient of the influence of water attitude on water literacy is -0.01 ($P > 0.05$). This finding is inconsistent with the conclusion of most scholars that attitude has a positive effect on literacy. One reason for this could be that the people in the surveyed areas have a low degree of direct influence on water literacy, and there is a particular "attitude" gap. The second is that attitude, as a consciousness variable, acts as a mediator and cannot directly and significantly affect water literacy. It may affect water literacy indirectly by affecting water behaviour (Xu et al. 2019). The issue of "attitude" gaps and mediating variables will continue to be explored in subsequent research.

6 Conclusion And Inspiration

In this study, a questionnaire was designed based on the water literacy evaluation index system, the data was collected in the pilot area, and a structural equation model was established for empirical research.

The influence paths among the evaluation factors of citizen water literacy are explored, and the influence degree coefficient of each path is obtained. The main conclusions are: First, citizen water knowledge has a significant positive impact on water attitudes and literacy, but water knowledge does not significantly positively impact water behaviour. Second, water attitude has a significant positive impact on water behaviour, but there is no significant positive impact on water literacy. In addition, according to the conclusion that water attitude can significantly affect water behaviour, and water behaviour can significantly affect water literacy, water attitude can indirectly affect water literacy through intermediary variables. Third, water behaviour has a significant positive impact on water literacy; finally, according to the constructed structural equation model, it can be found that most of the three-level indicators have factor loading coefficients above 0.5 (range 0-1). Only SXW7 and SXW10 have factor loading coefficients in the range of 0.4-0.5, indicating that the items corresponding to the observed variables can better explain the latent variables. The above results further verify the feasibility of the water literacy evaluation index system. Based on the research results, the following inspirations are obtained:

Water knowledge occupies a fundamental position in the process of improving water literacy. Water knowledge is limited to providing citizens with objective knowledge. More importantly, it is necessary to spread valuable knowledge, which is a value judgment and spiritual awe of the water's ecological environment and nature. It then rises to the moral realm, forms the ethical concept of the water environment, and develops the standard of ecological personality. Citizens' understanding of water knowledge and water ethics norms constitutes the criteria for judging whether their water-related behaviours conform to protecting water resources. Therefore, citizens' water knowledge and water ethics cognition guide citizens' water behaviour and occupy a fundamental position in promoting and cultivating water literacy.

Water attitude is a beautiful, emotional experience that people produce when they appreciate and experience the beautiful natural landscape and environment of water. Water emotion occurs in the citizens' water landscape and water environment appreciation and experience. In the emotion of water, citizens need positive and impulsive emotional factors as support. Citizens have a positive attitude towards water, and only then will they take the initiative to protect water resources. At the same time, satisfaction and pleasure can only be produced when specific water behaviour is practised with positive emotions. From the research results, water emotion is essential in developing water consciousness and implementing water behaviour. Without the stable support of emotion, the implementation behaviour cannot last long. Therefore, citizen water regime education is critical, through positive water emotion experience to stimulate and strengthen citizens' love and appreciation of nature and water.

Water behaviour refers to citizens who practice water resource protection in their daily behaviours under specific external requirements (saving water, loving water, and protecting water) and regulations. Water behaviour is a choice made on the premise of self-knowledge. There are currently no laws and regulations regarding many behaviours of citizens. Personal lifestyles, values, moral qualities, etc., will significantly impact the choice of water behaviour. The practice of water behaviour requires the correct values of water and scientific water knowledge and stable water emotion as support. Citizens' water behaviour is the

process of society's requirements for improving ecology and transforming ecological ethics into citizens' behaviours. Citizens' water behaviour will eventually be expressed through personal behaviour. Therefore, citizens' water behaviour is the external manifestation of water ecological ethics and water knowledge, and at the same time, it is also the result of the combined effect of water knowledge and water emotion.

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- Ethical Approval: The author promises to compliance with Ethical Standards
- Availability of data and materials: The author ensures that all data comes from social surveys. The software application complies with usage standards.

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Figures

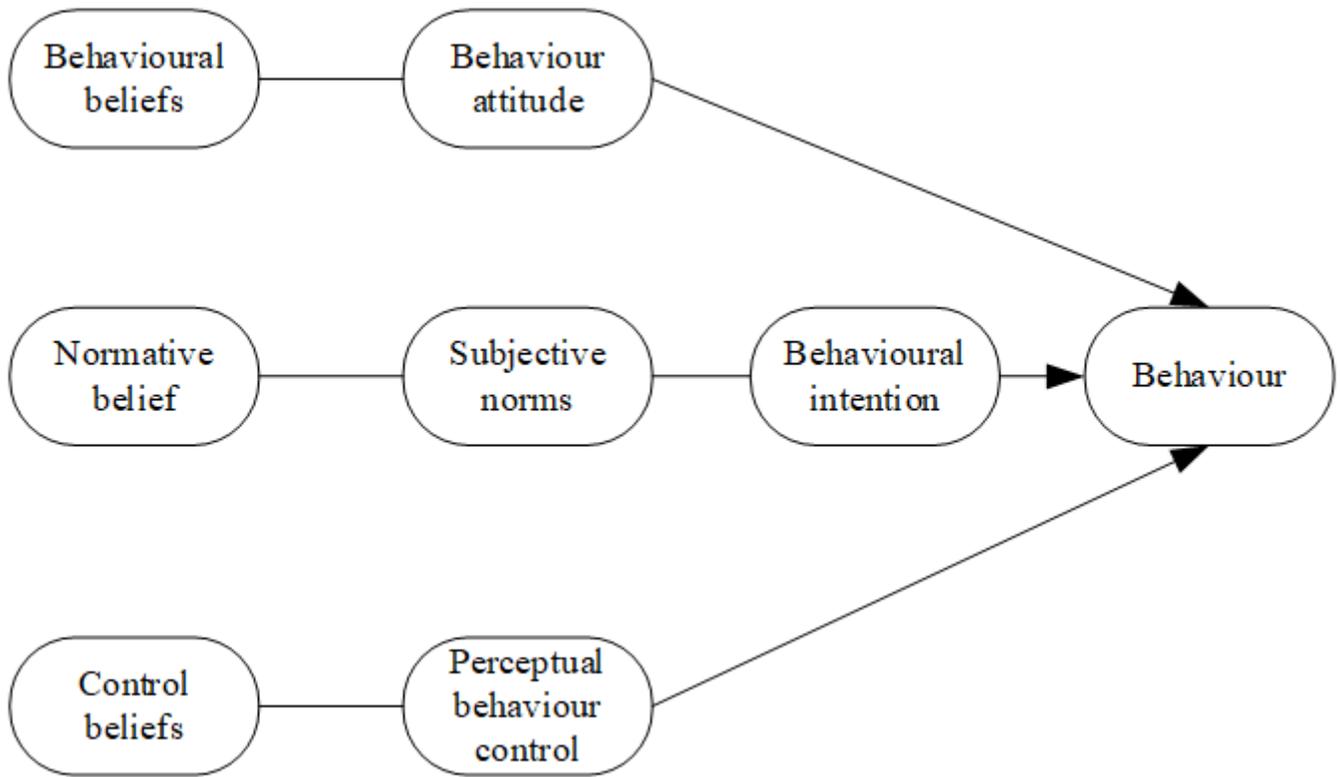


Figure 1

Theory of planning behaviour

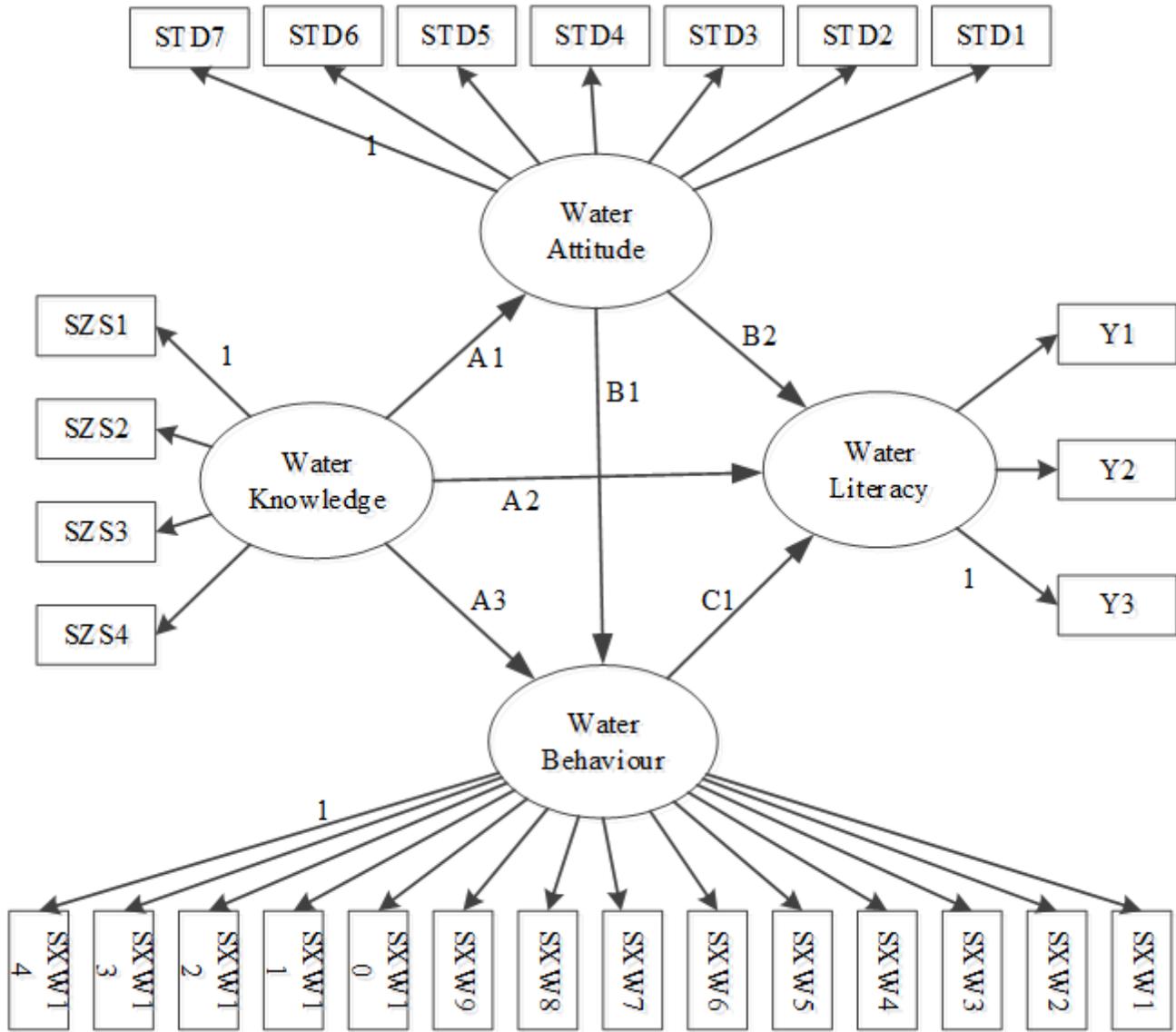


Figure 2

Initial conceptual model of factors affecting water literacy

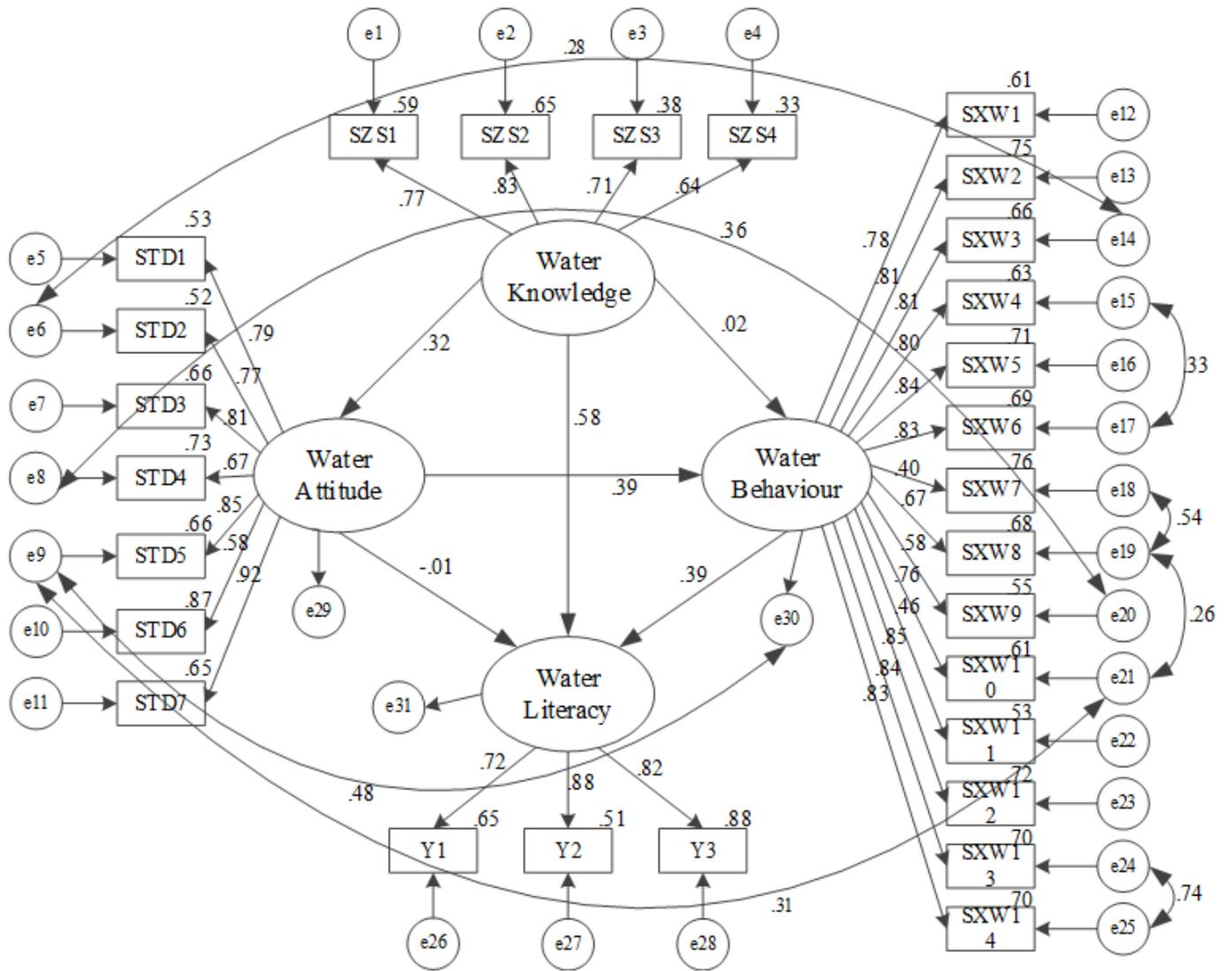


Figure 3

Structural equation model of water literacy evaluation index