AN AHP-BASED WEIGHTED ANALYSIS OF NETWORK KNOWLEDGE MANAGEMENT PLATFORMS FOR ELEMENTARY SCHOOL STUDENTS

Chung-Ping Lee,
Director of General Affairs Division, Chung-Hsiao Elementary School, Taiwan
cl87369@gmail.com

Shi-Jer Lou (Corresponding author),
Professor of Graduate Institute of Technological and Vocational Education,
National Pingtung University of Science and Technology, Taiwan
lou@mail.npust.edu.tw

Ru-Chu Shih,
Assistant Professor of Modern Languages,
National Pingtung University of Science and Technology, Taiwan
vincent@npust.edu.tw

Kuo-Hung Tseng,
Professor of College of Business Management,
Meiho University, Taiwan
gohome8515@gmail.com

ABSTRACT
This study uses the analytical hierarchy process (AHP) to quantify important knowledge management behaviors and to analyze the weight scores of elementary school students' behaviors in knowledge transfer, sharing, and creation. Based on the analysis of Expert Choice and tests for validity and reliability, this study identified the weight scores of four important knowledge transfer behaviors, three knowledge sharing behaviors, and four knowledge creation behaviors. The behaviors "storing related articles," "providing reports," and "replying to others' articles" obtained the highest scores, which were used as the criteria to evaluate the knowledge management platform of the network.
Keywords: Knowledge Management, Analytical Hierarchy Process

INTRODUCTION
With the arrival of the digital era, people search for and use knowledge through the Internet. Friedman argued that this made the world flatter in the twenty-first century (Friedman, 2007). The application of information technology has improved knowledge management and the efficiency of applying knowledge in groups (Uzunboylu, Eriş, & Ozcinar, 2010). Today, organization members can easily locate, organize, store, transfer, share, apply, and create knowledge. These capabilities significantly increase learning organizations' use of knowledge (McAndrew, Clow, Taylor, & Aczel, 2004). Using network technology, organization members can transfer and share their collected knowledge through network platforms to further accumulate and innovate knowledge (Rampai, & Sopeerak, 2011), thereby maximizing knowledge diffusion and innovation in an atmosphere of sharing and cooperation.

This study created a model for elementary school students' uses of network knowledge management platforms based on the literature analyses (Nurluoz, & Birol, 2011; Lee, Lu, Yang, & Hou, 2010). Because it is hard to represent concepts related to knowledge management and even harder to quantify behavior models, we used scientific tools to perform our analysis. Therefore, the main purpose of this study was to use analytical hierarchy processes to quantify behaviors related to knowledge management and to analyze the weighted scores of behaviors relevant to elementary school students, including knowledge transfer, knowledge sharing, and knowledge creation. These scores would become the criteria for evaluating network knowledge management platforms and elementary school students' performance of knowledge management behaviors.

LITERATURE REVIEW
The American Productivity & Quality Center (APQC) suggested that "knowledge management is a strategy to enable the right people to obtain appropriate knowledge at the appropriate time, which also assists members in sharing information to put it into practice to increase organizational effectiveness. By sharing information and bringing collective intelligence into full play, an organization's coping and innovative abilities can be further increased." Therefore, knowledge management uses systematic approaches to collect, analyze, transfer, understand, and create new, more valuable knowledge. Knowledge management can be broadly divided into knowledge acquisition, accumulation, dissemination, sharing, transfer, and creation (Zhao, 2010). The most

important of these aspects are knowledge transfer, knowledge sharing, and knowledge creation. This study investigated the relevant literature and the key behaviors that are currently applied in elementary school students' knowledge management platforms

1. Knowledge transfer
Knowledge transfer is a communication procedure in which knowledge receivers gain knowledge from knowledge providers (Liao & Hu, 2007). Knowledge can only be transferred through specific contexts (Nunes, Santoro, & Borges, 2009). It can be integrated into organizational contexts and group interactions to maximize individuals' knowledge acquisition. In addition, group knowledge can be transferred to individuals through network tools and teaching. Furthermore, the providers' expertise in knowledge transfer and skills in knowledge coding should be equivalent to those of the receivers (Blumenberg, Wagner, & Beimborn, 2009).

2. Knowledge sharing
In knowledge sharing, an individual voluntarily shares the knowledge and experiences that one has learned with other members in an organization (Ipe, 2003). Knowledge sharing can be achieved through methods such as distributed learning, database creation, discussions of interaction mechanisms, and the sharing of practical experiences. Knowledge sharing has a significant positive influence on organizational performance (Law & Ngai, 2008). Furthermore, an organization's culture of knowledge sharing is also influenced by a fair and open atmosphere, the pleasure of helping others, and effective knowledge (Yu, Lu, & Liu, 2010). Furthermore, the application of a tag system creates more efficient knowledge sharing than does traditional keyword search techniques (Hsieh, Su, Chen, & Chou, 2009).

3. Knowledge creation
Knowledge creation is a process that unites individuals and organizations through environmental knowledge transformation and dynamic interaction (Nonaka & Toyama, 2007). Some scholars (Yanga, Fang, & Lin, 2010) have proposed strategies for organizational knowledge creation (including exploratory, entrepreneurial, consolidation, and development strategies) from the perspectives of the private and public domains to increase organizational private knowledge and to create organizational intellectual property. In addition, in terms of the relationship among individuals, groups, and organizations, knowledge tends to be lost or interrupted during knowledge creation. In a mechanism known as a "knowledge buckle," the end of one kind of knowledge stimulates the rapid rise of another, which enables knowledge flow to successfully produce knowledge sharing and creation among all the participants (Lin, Lin, & Huang, 2008). The knowledge buckle can successfully trigger knowledge creation and sharing across the phases of socialization, externalization, and combination.

Based on the relevant behaviors and mechanisms in knowledge transfer, network platforms make synchronous and asynchronous communication possible. Through knowledge transfer, elementary school students can easily and directly use and receive group knowledge, which reduces the barriers to knowledge transfer and promotes organizational knowledge transfer. Furthermore, network knowledge management platforms enable members to interact anytime and anywhere to learn and transfer implicit knowledge. Explicit behaviors use a network knowledge management platform to collect student-related articles, select articles, download documents and attachments, and select topic links to increase the transfer of explicit network knowledge and promote the assimilation of knowledge.

In addition, interactive knowledge sharing assists elementary school students in their growth and development as well as provides the foundation for the learning and communication skills necessary for knowledge construction. Highly educated persons lead those who demand knowledge and encourage them to pursue knowledge through sharing and instruction. The demonstration and sharing of new knowledge can be achieved by implementing the internalization of knowledge in a fair and open organizational atmosphere. Knowledge management platforms provide students with report articles, encourage them to recommend and share others' articles, and use tag definitions to classify articles. These tools make network knowledge sharing more convenient and increase its effect.

Socialized and implicit knowledge can gradually become explicit through the knowledge buckle of a knowledge management platform. The interaction in network knowledge management platforms and exchange with elementary school students further integrates this individual knowledge into organizational group knowledge. The dialogue-based and practice-based sites provided through knowledge management platforms (Nonaka, Toyoma, & Konno, 2000) enable students to create and publish knowledge. For example, they can create new articles, upload personal files, attach relevant information links, and respond to the articles published by others anytime and anywhere. Thus, the interaction of implicit knowledge and the acquisition of new knowledge increase the creative space of network knowledge and the effectiveness of knowledge creation.

METHODOLOGY

The analytical hierarchy process (AHP), a hierarchically layered structure, was developed for decision making (Saaty, 2003). This paper proposes a taxonomy model that applies AHP to a network knowledge management platform. We then explain how AHP can be utilized on a network knowledge management platform. We then present the results of a specially designed questionnaire that we administered to eight experts. Finally, we present the weights for the network knowledge management platform.

The AHP for the proposed model is as follows (Lee, Yoon, & Kim, 2007; Saaty, 2003):

Step 1: Define the problem and determine the goal

This study created a network knowledge management platform and, based on a literature analysis, identified the key behaviors (knowledge transfer, knowledge sharing, and knowledge creation) as the criteria for analyzing network knowledge management platforms. Based on our analysis of the Expert AHP questionnaires, we established the weights of each kind of knowledge application in a network knowledge management platform to understand elementary school students' application of knowledge.

Step 2: Select the factors for the model

Based on the relevant behaviors for knowledge management that many studies have investigated, this study used knowledge management behaviors for network knowledge management platforms as the criteria to evaluate elementary school students' knowledge application behaviors on network knowledge management platforms. The behaviors in the first hierarchy included knowledge transfer, knowledge sharing, and knowledge creation, and those in the second hierarchy included the sub-criteria for knowledge transfer (e.g., collecting others' articles, selecting and reading others' articles, downloading relevant information, and selecting links), the sub-criteria for knowledge sharing (e.g., providing information, recommending others' articles, and using tag definitions), and the sub-criteria for knowledge creation (e.g., publishing new materials, uploading files, and responding to others' articles).

Step 3: Design the questionnaire

We designed the questionnaire to facilitate all of the possible pair-wise comparisons among the factors. Table 1 shows a typical nine-point scale for an AHP questionnaire (Saaty, 1980). Our questionnaire was designed to measure all possible importance ratios among the factors. Table 2 shows a simple example of the questionnaire, in which three factors are selected: Factors A, B, and C (Lee, Lin, Fang, Lo, & Wu, 2009). According to Table 2, Factor A is twice as important as Factor B because the ratio of Factor A to Factor B is 2:1. Row 1 corresponds to the ratio of Factors A to B. Thus, in Row 1, we mark "v" in the cell associated with a value of 2 (closest to Factor A). Similarly, the importance ratio of Factor A to Factor C is 3:1. The importance ratio of Factor B to Factor C is 1:5. Both of these ratios are shown in Table 2 (Rows 2 and 3).

Table 1: The definition and explanation of the AHP 9-point scale

Intensity of Relative Importance	Definition
1	Equal importance
3	Moderate importance of one over another
5	Essential or strong importance
7	Demonstrated importance
9	Absolute importance
2, 4, 6, 8	Intermediate values between the two neighboring scales

Table 2: A simple example of a questionnaire

Factor	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Factor
A (Row 1)								v										B
A (Row 2)							v											C
B (Row 3)													v					C

Step 4: Use the questionnaire to collect experts' opinions

After we administered the questionnaires to the experts, we used a matrix of importance ratios to describe the results of the pair-wise comparisons. Equation 1 shows the matrix of importance ratios associated with Table 2.

The matrix is a symmetrical and reciprocal matrix for the pair-wise comparisons.

$$\begin{array}{c} \\ A \\ B \\ C \end{array} \begin{array}{c} \begin{array}{ccc} A & B & C \end{array} \\ \begin{bmatrix} 1 & 2 & 3 \\ 1/2 & 1 & 1/5 \\ 1/3 & 5 & 1 \end{bmatrix} \end{array} \quad (1)$$

Step 5: Test the consistency
We used the Consistency Index (CI) to express the results' degree of consistency. Saaty (1980) defined the consistency index (CI) as follows:

$$CI = \frac{\lambda_{\max} - n}{n-1} \quad (2)$$

where $\lambda_{\max}$ is the maximum eigenvalue of the matrix of the importance ratios and n is the number of factors. Accordingly, Saaty (1980) defined the Constituency Ratio (CR) as follows:

$$CR = \frac{CI}{RI} \quad (3)$$

where the Random Index (RI) is given by Table 3 (Saaty, 1980). If the value of the consistency ratio (CR) is less than or equal to 0.1, the questionnaire is considered acceptable. If the CR is greater than 0.1, the questionnaire is not acceptable.

Table 3: Random Index

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Remark: n is the number of factors

Experiment setup and results
We used AHP to evaluate the weights of network knowledge management platforms and applied procedures, such as defining problems, determining goals, choosing model factors, and designing and using a questionnaire, to collect the experts' opinions. To ensure the consistency of the pair-wise comparisons for the expert questionnaire, we performed a consistency test to eliminate unreasonable evaluation values and to avoid adverse decision-making quality.

We designed an AHP, nine-point scale, expert questionnaire based on the structure chart of the three aspects of the network knowledge management platform (i.e., knowledge transfer, sharing, and creation), the relevant behaviors for each aspect (see Figure 1), the pair-wise comparisons for each behavior's importance, and the intensity of each behavior's relative importance. We analyzed the AHP expert questionnaire with Expert Choice and calculated the weight values as the criteria for evaluating knowledge management behaviors for the platform.

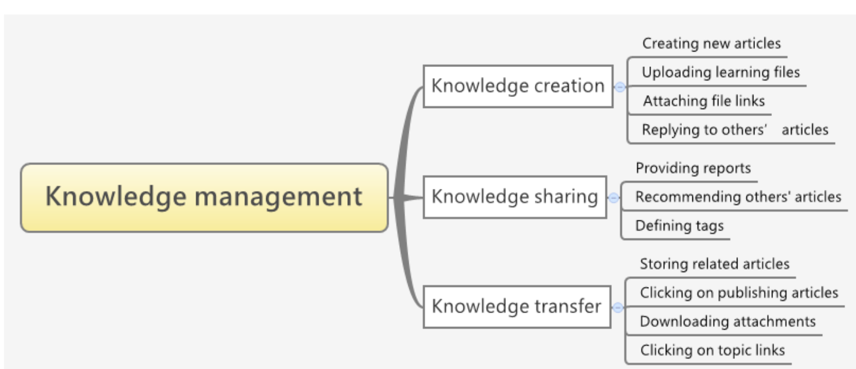

Figure 1: AHP Structure Chart of knowledge management -related behaviors

Consistency test

We selected the experts using three categories. The experts in the first category had expertise in education and teaching research (i.e., elementary school principals, directors, and teachers); the experts in the second category had expertise in technological network systems (i.e., college teachers and experts in educational technology); and the experts in the third category had expertise in human resources in knowledge management (i.e., college teachers and human resources managers). We selected eight experts and used Expert Choice to test the consistency of each questionnaire. In addition, we used the questionnaires that passed the consistency test to calculate weight values to obtain the weight of each behavior for network platform knowledge management.

Based on our analysis of the expert decision-making system in terms of knowledge transfer, six of the eight experts passed the consistency test (as shown in Table 4). In terms of knowledge sharing, five of the experts passed the consistency test (as shown in Table 5). In terms of knowledge creation, six of the experts passed the consistency test (as shown in Table 6).

Table 4: Maximum eigenvalue and the results of the consistency test for "knowledge transfer

Knowledge Transfer n=4				
Experts	λ_{max}	C.I.	R.I	CR
Expert A	4.027	0.009	0.9	0.01*
Expert B	4.837	0.279	0.9	0.31
Expert C	5.188	0.396	0.9	0.44
Expert D	4.216	0.072	0.9	0.08*
Expert E	4.270	0.090	0.9	0.10*
Expert F	4.135	0.045	0.9	0.05*
Expert G	4.027	0.009	0.9	0.01*
Expert H	4.000	0.000	0.9	0.00*

Note: * indicates CR ≦ 0.1, passing the consistency test

Table 5: Maximum eigenvalue and the results of the consistency test for "knowledge sharing"

Knowledge Sharing n=3				
Experts	λ_{max}	C.I.	R.I	CR
Expert A	3.499	0.249	0.58	0.43
Expert B	3.046	0.023	0.58	0.04*
Expert C	4.473	0.737	0.58	1.27
Expert D	3.070	0.035	0.58	0.06*
Expert E	3.035	0.017	0.58	0.03*
Expert F	3.000	0.000	0.58	0.00*
Expert G	3.406	0.203	0.58	0.35
Expert H	3.000	0.000	0.58	0.00*

Note: * indicates CR ≦ 0.1, passing the consistency test

Table 6: Maximum eigenvalue and the results of the consistency test for "knowledge creation"

Knowledge Creation n=4				
Experts	λ_{max}	C.I.	R.I	CR
Expert A	4.081	0.027	0.9	0.03*
Expert B	4.243	0.081	0.9	0.09*
Expert C	4.243	0.081	0.9	0.09*
Expert D	5.269	0.423	0.9	0.47*
Expert E	4.270	0.090	0.9	0
Expert F	4.261	0.072	0.9	0.08*
Expert G	4.351	0.117	0.9	0.13
Expert H	4.135	0.045	0.9	0.05*

Note: * indicates CR ≦ 0.1, passing the consistency test

Establishment of weight values

In this study, we used the expert questionnaires with values that passed the consistency test to ensure their reliability and validity. After excluding the questionnaires that did not pass the consistency test, we performed further calculations on the remaining questionnaires. We combined the index values with the weight values to obtain geometric means. We further calculated the means, based on the standard method, as the weights of network knowledge management behaviors and arranged them in the order of importance. To record elementary school students' knowledge application-related interactive behaviors for network knowledge management, we used AHP to input the factors and obtain their weights as the points to calculate knowledge application interactive behaviors for network knowledge management (see Table 7).

We applied the standardized weight values for knowledge application behaviors, which we obtained from the Expert AHP questionnaire analysis, to the established weight scores for the platform. These scores can be used as the basis to evaluate elementary school students' knowledge management behaviors for networks, as shown in Figure 2.

Table 7: Summary table combining expert questionnaire with weighted t-values

Knowledge management	Knowledge management behaviors	Original weight values	Standardized weight scores (points)
Knowledge transfer	Storing related articles	0.396	10
	Selecting published articles	0.199	5
	Selecting topic links	0.136	3
	Downloading attachments	0.269	7
Knowledge sharing	Providing reports	0.598	10
	Defining tags	0.247	4
	Recommending others' articles	0.155	3
Knowledge creation	Creating new articles	0.316	9
	Uploading learning files	0.210	6
	Attaching file links	0.110	3
	Replying to others' articles	0.364	10

Figure 2: Established weight scores for knowledge management platforms

CONCLUSIONS

Based on the literature review, this study summarized relevant behaviors, knowledge transfer, knowledge sharing, and knowledge creation as the design factors for a network knowledge management platform. According to our analysis of the AHP expert decision-making system, the following results of weight analysis was obtained for network knowledge application behaviors:

1. Among the relevant behaviors in "knowledge transfer," the most important was "storing related articles," followed by "downloading attachments," "selecting publishing articles," and "selecting topic links." Their weight values were 0.396, 0.269, 0.119, and 0.136, respectively, and the standardized weight scores were 10 points, 7 points, 5 points, and 3 points, respectively.

2. Among the relevant behaviors in "knowledge sharing behavior," the most important one was "providing reports," followed by "defining tags" and "recommending others' articles." Their weight values were 0.598, 0.247, and 0.155, respectively, and the standardized weight scores were 10 points, 4 points, and 3 points, respectively.

3. Among the relevant behaviors for "knowledge creation," the most important was "replying to others' articles," followed by "creating new articles," "uploading learning files," and "attaching file links." Their weight values were 0.364, 0.316, 0.210, and 0.110, respectively, and the standardized weight scores were 10 points, 9 points, 6 points, and 3 points, respectively.

To conclude, among the knowledge transfer behaviors for network knowledge management platforms, "storing related articles" can best transfer organizational knowledge from a platform to an individual network platform knowledge bank. This bank makes it easier for individuals to use knowledge and promotes efficient knowledge transfer. Therefore, the weight score of this behavior was high. In knowledge sharing, "providing reports" promotes the sharing of relevant topics and increases knowledge application resources in organizations. Therefore, the weight score of "knowledge sharing" was high. In knowledge creation, "replying to others' articles" was the major model for publishing creativity. Creative knowledge can only become explicit when organization members constantly interact with, respond to, and publish organizational knowledge, which increases group knowledge and is an important resource for knowledge creation. Therefore, the weight score of this behavior in "knowledge creation" was high. Furthermore, the unique interactive function of network knowledge management further increases the efficiency of knowledge transfer and sharing. For example, "downloading attachments" enables members to easily find the knowledge they need through the platform, which facilitates the transfer of organizational knowledge to individuals. The web articles and links necessary for "selecting topic links" help to transfer knowledge content and speed up the transfer of organizational knowledge to individuals. Using "defining tags" makes it easier for organizations to share knowledge, and the mechanism of "article recommendation" strengthens the sharing of team studies.

The limitations of the study are due to the AHP method assigns two factors with quantitative values for comparison, thus it was not easy to compare the attributes of tangible and intangible and some factors may be interdependent in some degree. Finally, the weight score model developed in this study can be used in future studies to evaluate the performance of elementary school students in network knowledge management behaviors.

REFERENCES

Blumenberg, S., Wagner, H. T., & Beimborn, D. (2009). Knowledge transfer processes in IT outsourcing relationships and their impact on shared knowledge and outsourcing performance. *International Journal of Information Management, 29*, 342–352.

Friedman, T. L. (2007). *The World Is Flat: A Brief History of the Twenty-first Century.* New York: Farrar, Straus and Giroux.

Hsieh, W.-T., Stu, J., Chen, Y.-L., & Chou, S.-C. T. (2009). A collaborative desktop tagging system for group knowledge management based on concept space. *Expert Systems with Applications, 36*, 9513–9523.

Ipe, M. (2003). Knowledge sharing in organizations: A conceptual framework. *Human Resource Development Review,* 2(4), 337–359.

Law, C. C. H., & Ngai, E. W. T. (2008). An empirical study of the effects of knowledge sharing and learning behaviors on firm performance. *Expert Systems with Applications, 34*, 2342–2349.

Lee, C. L., Lu, H. P., Yang, C. & Hou, H. T. (2010). A process-based knowledge management system for schools: a case study in Taiwan. *The Turkish Online Journal of Educational Technology, 9*(4), 10-21.

Lee, C. P., Lin, C. C., Fang, R. J., Lo, H., & Wu, M. C. (2009). A Taxonomy Model for Analyzing Project-Based Learning Using Analytical Hierarchy Process (AHP): A Case Study of Design of a Beer Company Website in an Elementary School. In N. Mastorakis, V. Mladenov & V. T. Kontargyri (Eds.), *Proceedings of the European Computing Conference* (Vol. 2, pp. 581-586). New York: Springer Science + Business Media.

Lee, S. K., Yoon, Y. J., & Kim, J. W. (2007). A study on making a long-term improvement in the national energy efficiency and GHG control plans by the AHP approach. *Energy Policy 35*, 2862–2868.

Liao, S.-H., & Hu, T.-C. (2007). Knowledge transfer and competitive advantage on environmental uncertainty: An empirical study of the Taiwan semiconductor industry. *Technovation, 27*, 402–411.

Lin, F.-r., Lin, S.-c., & Huang, T.-p. (2008). Knowledge sharing and creation in a teachers' professional virtual community. *Computers & Education, 50*, 742–756.

McAndrew, P., Clow, D., Taylor, J., & Aczel, J. (2004). The evolutionary design of a Knowledge Network to support knowledge management and sharing for lifelong learning. *British Journal of Educational Technology. 35*(6), 739–746.

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: A unified model of dynamic knowledge

creation. *Long Range Planning, 33*, 5–34.
Nonaka, I., & Toyama, R. (2007). Why do firms differ? The theory of the knowledge creating firm. In K Ichijo & I. Nonaka (Eds.), *Knowledge creation and management*. New York: Oxford University Press.
Nunes, V. T., Santoro, F. M., & Borges, M. R. S. (2009). A context-based model for Knowledge Management embodied in work processes. *Information Sciences, 179*, 2538–2554.
Nurluoz, Ö. & Birol, C. (2011). The impact of knowledge management and technology: an analysis of administrative behaviors. *The Turkish Online Journal of Educational Technology, 10*(1), 202-208.
Rampai, N., & Sopeerak, S. (2011). The development model of knowledge management via web based learning to enhance pre-service teacher's competency. *The Turkish Online Journal of Educational Technology, 10*(3), 249-254.
Saaty, T. L. (1980). *The Analytic Hierarchy Process* (Revised and extended 1988. ed.). New York: McGraw-Hill.
Saaty, T. L. (2003). Decision-making with the AHP: Why is the principal eigenvector necessary. *European Journal of Operational Research, 145*, 85-91.
Uzunboylu, H., Eriş, H., & Ozcinar, Z. (2010). Results of a citation analysis of knowledge management in education. *British Journal of Educational Technology*, no. doi: 10.1111/j.1467-8535.2009.01018.x.
Yanga, C.-W., Fang, S.-C., & Lin, J. L. (2010). Organizational knowledge creation strategies: A conceptual framework. *International Journal of Information Management, 30*, 231–238.
Yu, T.-K., Lu, L.-C., & Liu, T.-F. (2010). Exploring factors that influence knowledge sharing behavior via weblogs. *Computers in Human Behavior, 26*, 32–41.
Zhao, J. (2010). School knowledge management framework and strategies: The new perspective on teacher professional development. *Computers in Human Behavior, 26*, 168–175.

