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Key Advantages of Digital Learning in Group Decision Support System: Benefit Evaluation and Its Perspective †

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Abstract: In today's dynamic business landscape, companies need to enhance problem-solving efficiency to produce products or services to meet evolving customer needs. Fostering creative talent and utilizing Group Decision Support Systems (GDSS) have become crucial in the management of human resources and marketing. While empirical studies demonstrate the positive impact of GDSS on learning, a gap exists in understanding its correlation with outcomes like enhanced creativity. Thus, qualitative research is needed to uncover the cognitive processes for favorable results with the adoption of GDSS. We explored the relationship between Project-Based Learning (PBL), GDSS deployment, and outcomes in a cross-organizational study. Results highlighted PBL activities facilitated by GDSS and the key benefits of digital learning, and managerial and academic considerations were proposed.

Keywords: group decision supporting systems (GDSS); benefit evaluation; e-learning

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1. Introduction

To improve learners' learning effectiveness, it is necessary to use information technology effectively. Though the COVID-19 pandemic is over, it still affects our lives and work behaviors as it creates different experiences in learning activities. The Means–End Chain method provides three-level element connections at the attribute, result, and value levels to form a hierarchical relationship [1–4]. This hierarchical relationship presents the number of source links of elements and the number of times the element links are extended. The former is the In-Degrees (IDs) frequency and the latter is the Out-Degrees (ODs) frequency.

Benefit evaluation is used to judge the relative importance and specificity of various elements in the benefit structure. The three indicators of abstractness, centrality, and prestige are widely used in the evaluation and their values range between 0 and 1 [5]. The degree of abstraction is used to understand the degree of the benefit element in achieving the goal. The higher the value, the more abstract the benefit element is. The ratio is used to measure the ratio of IDs to ODs. The higher the centrality, the higher the proportion of IDs and ODs of the benefit element to total IDs and ODs. This means the benefit element plays an important role in the relationship between IDs and ODs. The ratio of the sum of IDs and ODs to the 'total number of links' is used for the measurement of benefit factors. The more the benefit, the higher the proportion of IDs to the total number of links. The ratio of the number of IDs to the number of total links is used to evaluate the importance of the benefit element in achieving the goal also using centrality and benefits.

In this study, we analyzed the characteristics of digital learning using a Group Decision Support System and explored the benefit elements that participants value

when learning in a Group Decision Support System. Benefits were evaluated to select important benefit factors.

2. Research Method

2.1. Research Design

To understand the connection between the implementation of topic-based learning and the Group Decision Support System, we conducted cross-organizational research for four months, in which the participants implemented innovative products in a Group Decision Support System. Naming and designing advertising slogans were used in project-based learning (PBL). The participants were students from various departments of three different colleges. A total of 168 participants were split into 42 groups, with each group comprising 4 participants. Each group included members of different genders, different colleges, different majors, and different regions. Thus, face-to-face discussions were difficult, and virtual group discussions were adopted.

2.2. Data Collection

We randomly selected 66 participants for interviews to obtain data for PBL in a Group Decision Support System and explored the key benefits of digital learning. The soft laddering method, one-to-one in-depth interviews, and a semi-structured questionnaire were used. On average, each person provided 2 to 3 items of learning experiences with an average of 2.55. The data obtained from the interviews were analyzed by three experts to extract the characteristic PBL activities. Using the benefit evaluation analysis, the key benefits of digital learning were identified.

2.3. Definitions

The variables of this study included digital learning attributes and digital learning benefits (Table 1).

Table 1. Operationalizing definitions of research concepts.

Code	Benefit Element	Definition	Description
	Attribute element		
A01	Information integration and classification	Ability to integrate and classify information	Thematic classification, columnar data display, data integration, and publication
A02	Immediacy	Not limited by time and space, providing the function to express opinions at any time	No time limit, not affected by time and space, can leave messages at any time
A03	Easy to operate	System is simple to operate and easy to learn	Easy to use, convenient and simple to operate
A04	Competition format	Implement project-based learning in a competitive format	Presented as a group competition
A05	Matchmaking group	Form a group of unfamiliar participants	Group up and cooperate with people you don't know
A06	Account and password protection	Protect participants' personal information with account and password	Account and password protection
A07	Anonymity	System operates anonymously	Anonymous
A08	Recordable information	System provides data storage	Computer record information
A09	Open platform	Platform for participants to discuss and share information	Platform where you can post URLs, post different messages, search and post different messages, and express your creativity
A10	Gamified learning	Provide participants with lively and stress-free interactive activities	More interactive among peers, presented in a lively, interesting, and less stressful way

Table 1. *Cont.*

Code	Benefit Element	Definition	Description
	Benefit element		
C01	Improving work efficiency	Operating time is flexible, increasing the time individuals can participate in activities	Save time, let the game go smoothly, have more time to discuss, do more things, enrich ourselves, facilitate discussion, have more time to think
C02	More chance of victory	Increase the likelihood of winning	Not to admit defeat, for honor, to gain fame, and to gain recognition from others
C03	Stimulating ideas	Generating or adding ideas through others or oneself	Inspire more ideas, you can throw ideas on it at any time, inspire your own ideas through other people's ideas, and a pile of ideas makes it easier to think.
C05	Increasing enthusiasm for participation	Promote participants to be more enthusiastic about using the system	More enthusiastic participation, convenient for discussion, easy to reach consensus, interesting, novel, and more want to use, stimulate curiosity
C06	Changing mindset	Change personal thinking patterns without being limited by existing thinking frameworks	Activate brain cells, break through existing ideas, improve creative quality, improve thinking, and integrate thinking
C07	Developing group spirit	Sense of the overall situation and a spirit of mutual assistance for collaboration and cooperation	Cultivate group chemistry and learn from each other's different strengths
C09	Meeting new friends	Make new friends and expand your network	Expand your circle of friends and expand your network
C10	Privacy	Ideas are protected	Attention to personal privacy and the protection of your ideas or data
C11	Improving competitiveness	Improve capabilities that can be demonstrated in competition	Improve competitive advantage, show ambition, and enhance competitiveness through group competition, future considerations, and future planning
C13	Expressing ideas freely	Express ideas freely without restraint	Easy to express ideas, express ideas without pressure, throw away whatever comes to mind, and think randomly
C14	Improving learning effectiveness	Opportunities to learn more and improve learning outcomes	Learn more, gain new knowledge easily, gain something, accumulate knowledge and experience

2.4. Analysis Method

We used the content analysis method to analyze the interview content of interviewees. The content analysis method is used to extract and analyze the central tendency of important concepts [6]. We conducted a literature review to determine the research scope and subject areas. For research samples, we established category rules to code the data and obtain the data statistics. The important concepts and occurrence of elements at each level were analyzed. To understand the importance of the attribute level and the interest level, abstraction, concentration, and prestige were used for analysis using the following.

1. Abstraction degree calculation method

$$\text{Degree of abstraction} = \text{number of IDs}/(\text{number of IDs} + \text{number of ODs}) \quad (1)$$

2. Concentration calculation method

$$\text{Centrality} = (\text{number of IDs} + \text{number of ODs})/\text{total number of links} \quad (2)$$

3. Prestige calculation method

$$\text{Prestige} = \text{number of IDs}/\text{total number of links} \quad (3)$$

2.5. Reliability and Validity Analysis

Intercoder reliability was used to test reliability, and the jury method was employed to ensure research validity. Three coders were classified to code the data and compare the analysis results. The average agreement of the three evaluators was 0.82. The reliability was calculated as follows.

$$\text{Reliability} = (\text{number of evaluators} \times \text{average mutual agreement})/[1 + (\text{number of evaluators} - 1) \times \text{average mutual agreement}] = (30.82)/(1 + 20.82) = 0.93 \quad (4)$$

The reliability was 0.93, which met the standard threshold (0.85) recommended by Kassarjain [7]. In the jury method, one professor and three graduate students familiar with the Means–End chain and the Group Decision Support System were invited.

3. Results

3.1. Group Decision Support System-Oriented Digital Learning Activities

The characteristics of digital learning were presented as 10 attribute elements. "Immediacy" was mentioned most frequently by 56.06% of the participants. More than half of the participants were not affected by time and space restrictions, and they thought the ability to express their opinions at any time was the most important in this learning model. "Recordable data (39.39%)", "anonymity (33.33%)", "open platform (31.82%)", and "competition format (30.30%)" were mentioned as the elements (Table 2). The functions and characteristics of the Group Decision Support System (immediacy, recordable data, anonymity, open platform) were found to be important. (see Table 2)

Table 2. Attribute occurrences.

Code	Attribute	Frequency	No. of Freq. Ratio	No. of People Ratio
A02	Immediacy	37	26.06%	56.06%
A08	Recordable information	26	18.31%	39.39%
A07	Anonymous	22	15.49%	33.33%
A09	Open platform	21	14.79%	31.82%
A04	Competition format	20	14.08%	30.30%
A10	Like a game	19	13.38%	28.79%
A05	Match strangers to group up	17	11.97%	25.76%
A01	Information integration and classification	9	6.34%	13.64%
A03	Easy to operate	7	4.93%	10.61%
A06	Account and password protection	1	0.70%	1.52%
	Total (66 participants)	142	100.00%	271.21%

3.2. Key Benefits of Digital Learning

We interviewed the participants to explore the benefits of digital learning. Among the 11 digital learning benefits, stimulating ideas was mentioned the most by the respondents, with 47 mentions, accounting for 71.21% of the 66 participants. More than 70% of the participants believed that such a learning design helped them have "stimulating ideas". The other mentioned benefits included "Improving work efficiency (45.45%)", "Freely expressing ideas (50.00%)", "Changing mindset (44.78%)", "Increasing enthusiasm for participation (40.91%)", and "Improving learning effectiveness (40.91%)" (Table 3).

Table 3. Key benefits of digital learning.

Code	Attribute	Frequency	No. of Freq. Ratio	No. of People Ratio
C03	Stimulating ideas	47	17.60%	71.21%
C01	Improving work efficiency	37	13.86%	56.06%
C13	Expressing ideas freely	33	12.36%	50.00%
C06	Changing mindset	30	11.24%	45.45%
C05	Increasing enthusiasm for participation	27	10.11%	40.91%
C14	Improving learning effectiveness	27	5.24%	40.91%
C11	Improving competitiveness	19	7.12%	28.79%
C07	Developing group spirit	17	6.37%	25.76%
C09	Meeting new friends	16	5.99%	24.24%
C02	More chance of victory	12	4.49%	18.18%
C10	Privacy	2	0.75%	3.03%
	Total (66 participants)	267	100.00%	404.55%

3.3. Benefit Evaluation of Digital Learning

We evaluated 11 learning benefit elements of digital learning in terms of abstractness, centrality, and prestige. Abstractness was mentioned most frequently by participants as "Privacy", followed by "Meeting new friends", and "Changing thinking". For centrality and prestige, "Stimulating ideas" was the most mentioned followed by "Improving work efficiency" and "Expressing ideas freely". In digital learning, "Stimulating ideas", "Improving work efficiency", and "Expressing ideas freely" were important benefit elements (see Table 4).

Table 4. Benefit evaluation results of digital learning.

Code	Benefit Element	In	Out	I+O	Abstractness	Centrality	Prestige
C01	Improving work efficiency	37	37	74	0.500	0.166	0.083
C02	More chance of victory	12	12	24	0.500	0.054	0.027
C03	Stimulating ideas	47	48	95	0.495	0.213	0.106
C05	Increasing enthusiasm for participation	27	27	54	0.500	0.121	0.061
C06	Changing mindset	31	30	61	0.508	0.137	0.070
C07	Developing group spirit	17	17	34	0.500	0.076	0.038
C09	Meeting new friends	16	15	31	0.516	0.070	0.036
C10	Privacy	2	1	3	0.667	0.007	0.004
C11	Improving competitiveness	19	19	38	0.500	0.085	0.043
C13	Expressing ideas freely	33	33	66	0.500	0.148	0.074
C14	Improving learning effectiveness	27	27	54	0.500	0.121	0.061

4. Conclusions

The digital PBL in the Group Decision Support System showed "Immediacy", "recordable data", "anonymity", "open platform", and "competition format". On the asynchronous system platform, the digital PBL allowed learners to be multifunctional (without time and space restrictions, store and share learner opinions, everyone has a fair right to express their opinions, participate anonymously without pressure, and use competitions to enhance participation and stimulate engagement). It provided learners with a rich learning experience. A total of 11 benefits in the digital PBL were determined, among which "stimulating ideas", "improving work efficiency", "expressing ideas freely", "changing mindset", "increasing enthusiasm for participation", and "enhancing learning effectiveness" were important. The Group Decision-making Support System directly impacted learners' way of thinking (stimulating ideas and changing mindset) and allowed for benefits in learners' learning process such as improving participation enthusiasm, work efficiency, learning effectiveness, involving attitude, learning process, and learning results. The important key factors in digital learning included "stimulating ideas", "improving work efficiency", and "expressing ideas freely". By sharing information in the Group Decision Support System, learners

can generate more diverse ideas in a stress-free digital learning environment and express their ideas freely without inhibition. In the asynchronous system, the group members participated in learning to learn flexibly without being restricted by time and space. Such benefits meet the needs of college students whose lives and schedules are very tight.

The Group Decision-making Support System combined with digital PBL allows for the functions of the platform and benefits such as "stimulating ideas", "improving work efficiency", and "freely expressing ideas". PBL with competition strengthens the learning behavior of participants. It is recommended for teachers to combine group decision-making platforms and PBL to diversify learning activities and designs. Then, learning participation and activities can be used to bring benefits. The Group Decision Support System enables group interaction and cooperation in a virtual environment. Although it brings diverse benefits, it may have negative effects. The benefits are also limited to the system. Therefore, more learning activities are demanded in the learning activities for students to have diverse learning experiences.

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References

1. Gutman, J. A means-end chain model based on consumer categorization processes. *J. Mark.* **1982**, *46*, 60–72. [CrossRef]
2. Gutman, J. Means–end chains as goal hierarchies. *Psychol. Mark.* **1997**, *14*, 545–560. [CrossRef]
3. Zanoli, R.; Naspetti, S. Consumer motivations in the purchase of organic food: A means-end approach. *Br. Food J.* **2002**, *104*, 643–653. [CrossRef]
4. Zhao, Y.; Agyeiwaah, E. Exploring value-based motivations for culture and heritage tourism using the means-end chain and laddering approach. *J. Herit. Tour.* **2023**, *18*, 594–616. [CrossRef]
5. Pieters, R.; Baumgartner, H.; Allen, D. A means-end chain approach to consumer goal structures. *Int. J. Res. Mark.* **1995**, *12*, 227–244. [CrossRef]
6. Krippendorff, K. Content analysis. *Int. Encycl. Commun.* **1989**, *1*, 403–407.
7. Kassarjian, H.H. Content analysis in consumer research. *J. Cons. Res.* **1977**, *4*, 8–18. [CrossRef]

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