Interactive Effects of Graphic Organizer Strategy and Strategy Preference on Self-Paced Video Learning

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Abstract: *This study explored the mutual influence of GO strategy (watching vs. generating) and strategy preference (with GO preference vs. without GO preference) on the learning outcomes (indicated by learning performance, intrinsic motivation, metacognition and cognitive load) when learning from self-paced videos. The results showed that when generating GO, GO preference increased participants' knowledge retention in both immediate and delayed performance, perceived value of intrinsic motivation and reduced participants' cognitive load. Additionally, when watching GO, GO preference increased participants' perceived value of intrinsic motivation and reduced participants' perceived pressure of intrinsic motivation and cognitive load. Furthermore, GO preference can improve participants' knowledge retention in delayed performance by improving their competence and learning confidence. The results suggested the positive effect of GO preference on the learning outcomes when learning self-paced video with generating and watching a GO.*
Keywords: instructional videos, graphic organizer, strategy preference

1. Introduction

The rise of internet technologies has positioned video learning as a prominent educational tool. However, learners often passively consume video content, limiting opportunities for active knowledge construction—a critical component of meaningful learning (Fiorella & Mayer, 2016; Mohammadhassan et al., 2022). This passive engagement may reduce focus, persistence, and learning efficiency compared to traditional methods (Crook & Schofield, 2017). To address this, researchers emphasize the need for strategies that promote deeper cognitive processing (Yang et al., 2021).

Graphic organizers (GOs) as visual tools like concept maps and flowcharts that enable learners to represent hierarchical relationships and reorganize information spatially (Novak & Gowin, 1984). By structuring knowledge visually, GOs enhance comprehension, retention, and retrieval (Bean et al., 1986). While generating GOs is theorized to foster generative learning through active engagement, debates persist regarding its efficacy versus passively watching pre-made GOs. Proponents argue that generation induces deeper cognitive processing, whereas critics highlight potential cognitive overload risks (Fiorella & Mayer, 2016). Learner differences further complicate this dynamic. Strategy preference is defined as an individual's tendency to adopt specific learning approaches, which can significantly influences learning outcomes (Vos et al., 2011). For GOs, learners with a GO preference (habitual, self-directed use of such tools) may demonstrate superior performance, motivation, and metacognitive regulation due to strategy familiarity (Eielts et al., 2020). Conversely, non-preferring learners might experience cognitive strain when compelled to use GOs.

This study investigates the interactive effects of GO strategy (generating vs. watching) and GO preference on self-paced video learning outcomes, including performance, motivation, cognitive load and metacognition. We hypothesize that GO preference will amplify the benefits of generating GOs, as heightened motivation and metacognition may optimize generative processing without excessive cognitive demands. In contrast, preference may exert minimal influence when learners passively watch GOs. This aligns with prior work suggesting strategy efficacy depends on alignment with learner characteristics (Vos et al., 2011; Yang et al., 2021).

2. Method

2.1. Participants and design

One hundred and six Chinese undergraduates (aged 18-23, SDage = 1.06; 93 females) from diverse majors (e.g., Pedagogy, Information Engineering) participated voluntarily in a 2×2 between-subjects design. Participants were divided into the with GO preference group and the without GO preference group (negative responses to both), then randomly assigned to either watch or generate a GO during video learning (the interface is shown in Figure 1-2). All participants provided informed consent and received 12-15 CNY compensation. This study received approval from the local ethics committee.

Fig.1 Screenshot of the learning interface of the watching GO group.

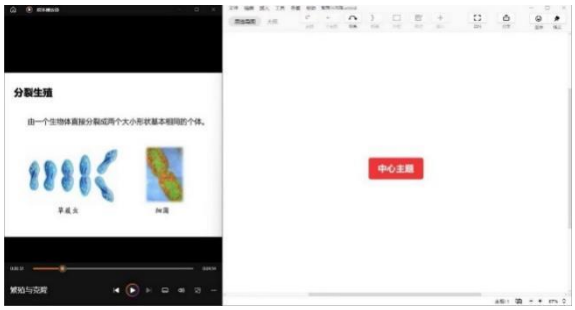

Fig.2 Screenshot of the learning interface of the generating GO group.

2.2. Learning material

The instructional video was adapted from the video lecture used by Pi et al. (2019). The topic was Reproduction and Cloning in biology. It was divided into three parts: classification of reproduction, vegetative reproduction and cloning. This video lasted about 5 minutes. Participants were allowed to control the video, but the maximum learning time was 15 minutes.

2.3. Measurements

The strategy preference questionnaire assessed participants' inclination toward GOs using two criteria: (1) interest in GOs (1 = "not at all true" to 5 = "very true"; participants rating 4-5 classified as "interested"), and (2) frequency of GO use (0 = "less than once a month" and 1 = "more than once a month"; participants rating 1 classified as "frequent"). The prior knowledge test evaluated baseline understanding with one fill-in-the-blank (1 point) and five multiple-choice questions (10 points; total = 11, Cronbach's $\alpha = 0.62$). The learning performance test measured retention and transfer immediately and one week later. Retention included 17 fill-in-the-blanks (17 points; Cronbach's $\alpha = 0.70$ and 0.73), while transfer combined seven multiple-choice (14 points), one fill-in-the-blank (1 point), and one short-answer question (5 points; total = 20, Cronbach's $\alpha = 0.61$ for both). The intrinsic motivation scale comprised 12 items across four subscales (interest, competence, value and pressure) rated on a 7-point Likert scale (1 = "not at all true" to 7 = "very true"). Subscale scores were averaged (pressure items reverse-scored), with acceptable reliability (Cronbach's α = 0.75-0.86). The cognitive load scale included three 7-point Likert items (total score averaged; Cronbach's $\alpha = 0.79$). The judgment of learning (JOL) scale measured metacognitive confidence via two items: self-rated accuracy (0-100) and predicted test performance. Scores were averaged and Cronbach's $\alpha = 0.91$. Metacognition accuracy was derived from the absolute difference between JOL scores and actual performance.

2.4. Procedure

The experiment was conducted in a lab and lasted about 40 minutes. Firstly, the researchers introduced the basic information and procedure of the experiment to the participants and led them to sign the informed consent (5 min). Afterward, the participants filled out the demographic questionnaire (e.g., gender, age, and major) and the prior knowledge test (5 minutes). Subsequently, all participants were assigned to one of four groups and asked to watch or generate the GO while watching the instructional video (15 min). After learning, they completed the immediate learning performance test, the intrinsic motivation test and the cognitive load test (15 minutes). A week later, they completed the delayed learning performance test online.

3. Results

Data met normality (skewness and kurtosis within -2 to 2) and homogeneity of variance (ps > .05), justifying ANOVA. Pretests showed no group differences ($F(3, 102) = 0.43$, $p = .730$, $\eta p2 = .013$).

Immediate knowledge retention showed a marginal main effect of strategy preference ($F(1, 102) = 3.64$, $p = .059$, $\eta p2 = .034$) and an interaction effect ($F(1, 102) = 4.54$, $p = .036$, $\eta p2 = .043$). Participants with GO preference outperformed without GO preference after generating GOs (MD = 2.39, $p = .006$). Similarly, delayed knowledge retention showed a main effect of strategy preference ($F(1, 102) = 6.30$, $p = .014$, $\eta p2 = .058$) and an interaction effect ($F(1, 102) = 3.92$, $p = .050$, $\eta p2 = .037$). Participants with GO preference outperformed without GO preference after generating GOs (MD = 2.77, $p = .002$). But knowledge transfer showed no significant effects (ps > .050).

Interest showed a main effect of strategy preference ($F(1, 102) = 148.89$, $p < .001$, $\eta p2 = .593$) and a main effect of GO strategy ($F(1, 102) = 12.24$, $p = .001$, $\eta p2 = .107$). Participants with GO preference and watched GOs both reported higher interest (MD = 1.35, $p < .001$; MD = 0.86, $p = .001$). Competence only showed a main effect of strategy preference ($F(1, 102) = 11.33$, $p = .001$, $\eta p2 = .100$). Participants with GO preference reported higher interest (MD = 1.35, $p < .001$). Value showed a main effect of strategy preference ($F(1, 102) = 144.81$, $p < .001$, $\eta p2 = .587$) and a marginal interaction effect ($F(1, 102) = 3.17$, $p = .078$, $\eta p2 = .030$). Participants with GO preference reported higher value after both watching and generating GOs (MD = 1.40, $p < .001$; MD = 1.04, $p < .001$). Pressure showed a main effect of strategy preference ($F(1, 102) = 14.87$, $p < .001$, $\eta p2 = .127$) and an interaction effect ($F(1, 102) = 5.44$, $p = .022$, $\eta p2 = .051$). Participants with GO preference reported lower pressure after watching GOs (MD = 1.30, $p < .001$).

JOL only showed a main effect of strategy preference ($F(1, 102) = 18.07$, $p < .001$, $\eta p2 = .151$) and metacognitive accuracy showed no effects (ps > .050). Participants with GO preference showed greater confidence (MD = 13.06, $p < .001$).

Cognitive load showed a main effect of strategy preference ($F(1, 102) = 36.42$, $p < .001$, $\eta p2 = .263$) and a marginal interaction effect ($F(1, 102) = 3.49$, $p = .065$, $\eta p2 = .033$). Participants with GO preference reported lower cognitive load after both watching and generating GOs (MD = 1.24, $p < .001$; MD = 0.65, $p = .004$).

Mediation analysis (PROCESS v4.0) identified competence ($a \times b = 0.51$, 95% CI [0.0930, 1.1066]) and JOL ($a \times b = 1.21$, 95% CI [0.5397, 1.9974]) as mediators between GO preference and delayed retention, suggesting their roles in enhancing retention through intrinsic motivation and metacognitive confidence.

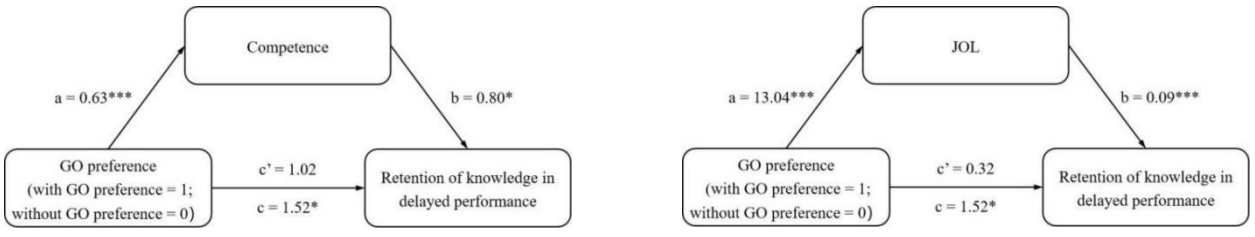

Fig.3 Results of the mediation analysis ($^{*}p < .05$; $^{***}p < .001$).

4. Discussion and Conclusion

This study demonstrates that participants' GO strategy preference significantly enhances learning outcomes in self-paced video instruction. Participants with GO preference showed superior knowledge retention, higher intrinsic motivation, and reduced cognitive load after generating GOs. When watching GOs, participants with GO preference exhibited stronger motivation and lower cognitive demands. Notably, GO preference improved delayed retention through enhanced competence and confidence development. These results may be due to the fact that participants without GO preference likely struggled with GO generation's working memory demands (Wang et al., 2021). While generating GOs remains cognitively challenging even for participants with GO preference (Fiorella & Mayer, 2015), our findings emphasize the motivational benefits of strategy alignment (Hidi & Renninger, 2006). The absence of transfer differences suggests future research should employ more sensitive assessments across task difficulty levels (Kalyuga et al., 2003). These results underscore the pedagogical value of cultivating GO preference and metacognitive awareness (Mazancieux et al., 2023) in self-directed learning environments.

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