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# Chunking Technique with Writing is Thinking to Control Students' Extraneous Cognitive Load

**Meirin Dwiningtyas Putri[1,] *, Adi Rahmat[2], Yayan Sanjaya[3],**

Biology Department, Matematics and Science Faculty, Universitas Pendidikan Indonesia-Bandung
[1] meirindwi@gmail.com*; [2] adirahmat@upi.edu ; [3] yayan@upi.edu
* Corresponding author: meirindwi@gmail.com

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**ABSTRACT**

Extraneous cognitive load (ECL) is a related to the design or learning strategies in learning activities. This study aims to control students' extraneous cognitive load by using chunking technique with writing is thinking in the human reproductive system learning. This research was conducted at one of the Senior High School in Tasikmalaya City for the 2020/2021 academic year. The research method used quasi-experimental with posttest only control group design. The research subjects were 56 samples divided into two groups, namely the experimental group

(28 students) and the control group (28 students). The instrument used in this research is a subjective rating scale questionnaire with a scale of 1 to 8 including indicators of the student responses about the learning strategies used and student responses to the given task. The results showed that the students' extraneous cognitive load of the experimental group was lower than the control group. Based on the result of statistic analysis using SPSS version 23 software, the students' extraneous cognitive load between the experimental group and the control group was significantly different.



**Keywords:** Extraneous Cognitive Load, Human Reproductive System, Chunking Technique Writing is Thinking

## Introduction

The process of the effective learning activities needs to consider students' working memory capacity (Sweller, 1988). Working memory is a place to operate information, organize it to be stored or discarded and then connect it with other information (Mayasari, 2017). Everyone has a limited working memory capacity so that can cause students to be overload when receiving and processing excess information. Therefore, it is necessary to optimize the cognitive load in working memory capacity.

Cognitive load is a demand in carrying out certain tasks that burden the cognitive processing system (Scharfenberg & Bogner, 2013). Cognitive load is influenced by three components including *intrinsic cognitive load* (ICL) which has an interconnection with working memory, *extraneous cognitive load* (ECL) which is related to learning design and *germane cognitive load* (GCL) which is related to the load of constructing cognitive schemas (Van Merriënboer & Sweller, 2010).

The use of learning strategies has an important role in controlling students' cognitive load. Cognitive load theory suggests that the reduction of cognitive load that comes from the learning environment (*extraneous cognitive load*) can affect how to learn student in managing any information received the cognition system (Jong, 2010). *Extraneous cognitive load* (ECL) component relates to the students' mental effort (UM) on external aspect or extraneous aspect such as the design or learning strategies carried out. Then, *extraneous cognitive load* needs to be an important consideration when design learning so that learning strategies are able to facilitate cognitive complexity (Juanengsih et al., 2018).

The learning process involves interaction between the teacher and the students. Learning strategies used by teachers should be able to assist students in processing information to build their knowledge. Biology learning is considered a difficult material and too much memorization makes it difficult for students to learn. Difficulty in learning is defined as a condition where students cannot learn optimally which is caused by the existence of an obstacle and obstacle. Biology learning material that is considered difficult is one of the materials for the human reproductive system (Harahap & Nasution, 2018; Kusuma et al., 2017; Raida, 2018). Based on an interview with a biology teacher at a senior high school in Tasikmalaya City, human reproductive system learning is considered complex because students still have difficulty remembering Latin names, memorizing concepts and abstract bodily processes. In addition, the results of the average student test in the previous year showed that 46% of the 35 students who were able to get a score above the KKM so that there were still students who were still burdened in their working memory caused by the design or learning strategy carried out. This shows that there is a load in students' working memory which is limited, so there is a need for learning strategies that facilitate students in processing information so that extraneous cognitive load can be controlled. One of them is by using the chunking technique combined with writing is thinking. The chunking technique combined with writing is thinking is a learning strategy in which information is divided into meaningful pieces, then students rewrite the information using simple language so that it can be easily remembered and understood in cognitive processing.

Chunking technique combined with writing is thinking can help students reduce the amount of information that must be stored in working memory into several pieces

of information then the students rewrite it into simpler terms or language so that the use of thinking methods can help students in the learning process (Fontain & Doyle, 2012; Greenstein, 2013). Therefore, the author formulates the problem, namely "How is the extraneous cognitive load of students in the human reproductive system learning with chunking techniques combined with writing is thinking?". The purpose of this study is to control students' extraneous cognitive load by using chunking techniques combined with writing is thinking in the human reproductive system learning. In this article, the author describes the results of research on the use of chunking techniques combined with writing is thinking to control students' extraneous cognitive load in the human reproductive system learning.

## Methods

The research method used is a quasy experimental research with a posttest only control group design. This research involved 56 students in class XI MIPA one of the Senior High School in Tasikmalaya City which were divided into two groups, namely the experimental group (28 students) and the control group (28 students). The sampling technique used is purposive sampling. Purposive sampling is a technique used based on certain considerations. The criteria for the sampling technique used were based on students' abilities which were not much different between the experimental group and the control group based on the average student score. This research was carried out starting from April – May 2021 on the material of the human reproductive system in two meetings. The first meeting discussed the male reproductive system (covering the structure and function of male reproductive organs and the male reproductive process) and the second meeting discussed the female reproductive system (covering the structure and function of female reproductive organs and female reproductive processes). The use of the chunking technique is carried out by the teacher, then the students carry out writing is thinking activities.

Table 1. Research Design *Posttest Only Control Group Design*

| Group | Treatment | Posttest |
|---|---|---|
| Experiment | $X_1$ | O |
| Control | $X_2$ | O |

Source: Creswell (2012)

Description:
$X_1$ : learning using *chunking* and *writing is thinking*
$X_2$ : conventional learning
O : measurement *extraneous cognitive load*

The research instrument to measure students' extraneous cognitive load was using a *subjective rating scale* questionnaire (Klepsch et al., 2017; Klepsch & Seufert, 2020) which has been validated by expert lecturers. Data collection was carried out after students studied the human reproductive system given by the teacher. Giving scores on the subjective rating scale questionnaire using a Likert scale from a range of 1 to 8 which is converted to a scale of 100. the lower the mental effort score obtained by students, the lower the extraneous cognitive load that students do in learning (Rahmat & Hindriana, 2014)

Table 2. *Subjective Rating Scale* Indicator for Measuring *Extraneous Cognitive Load*

| No | Cognitive Load Component | Indikator | Number of Statements |
|---|---|---|---|
| 1 | ECL | Student responses about the learning strategies used | 7 |
| 2 | | Student responses to the given task | 2 |

Source: Klepsch et al., (2017); Klepsch & Seufert, (2020) with the author's adaptation

Table 3. Measurements Scale of *Subjective Rating Scale* Questionnaire

| Score | Response |
|---|---|
| 1 | Very-very agree |
| 2 | Strongly agree |
| 3 | Agree |
| 4 | Quite agree |
| 5 | Don't agree |
| 6 | Disagree |
| 7 | Strongly disagree |
| 8 | Very-very disagree |

The assessment of the subjective rating scale questionnaire was analyzed quantitatively with the following formula:

$$score = \frac{number\ of\ scores\ obtained\ by\ student}{total\ student\ score}\ x\ 100$$

Table 4. Category of *Extraneous Cognitive Load*

| Score | Category |
|---|---|
| 80 – 100 | Very high |
| 60 – 79 | High |
| 40 – 59 | Medium |
| 20 – 39 | Low |
| 0 – 19 | Very Low |

After the extraneous cognitive load data for the experimental group and control group students were obtained, data analysis facilitated by SPSS version 23 software was carried out including prerequisite tests including normality test using the Shapiro-Wilk test and homogeneity test using the Levene-test. Then it was continued with the mean difference test using the Mann Whitney Test with a significance level of 5% to determine whether the extraneous cognitive load data of the experimental group and control group students were significantly different or not.

## Results and Discussion

Learning using chunking techniques combined with writing is thinking aims to control students' extraneous cognitive load.

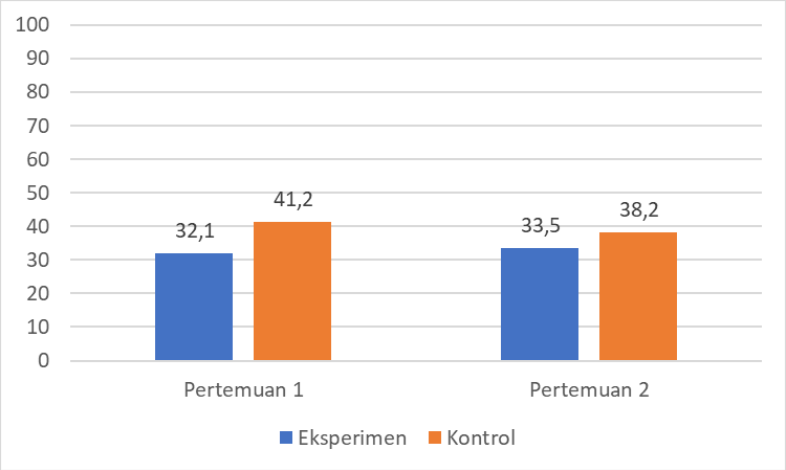


Figure 1. Average *Extraneous Cognitive Load* Value

Based on the results of the study, Figure 1. shows that the average extraneous cognitive load score of students at the first meeting of the experimental group obtained an average score of 32.1, including the low category, while the control group with an average value of 41.2 was in the medium category. Meanwhile, in contrast to meeting 2, the experimental group and the control group both obtained an average in the low category. However, the experimental group obtained an average score of 33.5 lower than the control group with an average score of 38.2. These findings indicate that the experimental group has a lower extraneous cognitive load than the control group. A low extraneous cognitive load illustrates the low mental effort made by students during learning which means that the design or learning strategy has been carried out well. The results of statistical tests obtained from the average overall meeting are presented in Table 5.

Table 4. Student *Extraneous Cognitive Load* Data

| **Component** | ***Extraneous Cognitive Load* Data** | |
|---|---|---|
| | **Experiment** | **Control** |
| Number of Sample (n) | 28 | 28 |
| Average (x) | 32,79 | 39,75 |
| SD | 7,7 | 6,9 |
| Highest Value | 45 | 64 |
| Lowest Value | 15 | 29 |
| | Normality test (Shapiro-Wilk) | |
| Sig. | 0,063 > 0,05 | 0,005 < 0,05 |
| Conclusion | Normal | Abnormal |
| | Homogeneity test (Levene Test) | |
| Sig. | 0,527 > 0,05 | |
| Conclusion | Homogen | |
| | T Test (Mann Whitney) | |
| Sig. | 0,002 < 0,05 | |
| Conclusion | Significantly different | |

The statistical test results presented in Table 5. show that the average extraneous cognitive load in the experimental group is 32.79, which is lower than the control group, which is 39.75. Furthermore, the results of the normality test using Shapiro-

Wilk showed that the experimental group obtained data with a normal distribution (α > 0.05) and the control group obtained data that were not normally distributed (α < 0.05), then the next test was carried out with non-parametric statistical tests, namely Mann Whitney with a significance of 0.002 (α <0.05) so the test results show that the extraneous cognitive load of students in the experimental group and the control group is significantly different. These findings indicate that the use of chunking techniques combined with writing is thinking can control students' extraneous cognitive load in the human reproductive system learning.

Chunking technique can help reduce students' cognitive load by cutting information into simpler and more meaningful ways to make students able to manage cognitive systems. Then continued with writing is thinking students are able to write down understanding that has not been organized to be more fully coordinated, then the use of thinking by writing it into a simpler language can help students in the learning process (Greenstein, 2013; Leonard, 2015).

Mental effort is an effort that is done other than or outside the capacity of the cognitive system (Rahmat & Hindriana, 2014). The results of the average score of low mental effort indicate a low extraneous cognitive load. This means that the design or learning strategy uses chunking techniques combined with writing is thinking which is done well in the learning process. The results of the relevant research according to Putri (2018) suggests that the low mental effort describes the learning strategies used by the teacher in explaining the excretory system is good. Research conducted by Garnasih (2018) showed that differences in students' mental effort caused the experimental group's extraneous cognitive load to be more controlled than the control group in plant classification learning. Furthermore, according to Nurismawati et al., (2021) suggesting a low extraneous cognitive load score indicates that the writing is thinking strategy has an impact on decreasing extraneous cognitive load in light and optical learning.

## Conclusion

The use of chunking techniques combined with writing is thinking can control students' extraneous cognitive load in learning the human reproductive system. This is indicated by the low extraneous cognitive load of students on the average value of the extraneous cognitive load of students which causes low mental effort made by students during learning which means that the design or learning strategy has been done well.

## References

Creswell, J. W. (2012). *Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research* (Fourth Edi). Pearson.

Fontain, S., & Doyle, K. E. (2012). Learning by Chunking. *Encyclopedia of the Science Learning*, 1814–1817. https://doi.org/http://doi.org/10.1007/978-1-4419-1428-6_1042

Garnasih, T. (2018). Kemampuan Siswa dalam Mengelola Extraneous Cognitive Load Pada Pembelajaran Klasifikasi Tumbuhan Menggunakan Apresepsi Tayangan Video. *BioEdUIN: Jurnal Program Studi Pendidikan Biologi*, *8*(2).

Greenstein, G. (2013). Writing is thinking: Using writing to teach science. *Astronomy*

*Education Review*, *12*(1). https://doi.org/10.3847/AER2012037

Harahap, F. D. S., & Nasution, M. Y. (2018). Analisis Kesulitan Belajar Siswa Pada Materi Virus di Kelas X MIPA SMA Negeri 1 Rantau Selatan Tahun Pembelajaran 2017/2018. *Jurnal Pelita Pendidikan*, *6*(2), 71–78.

Jong, T. De. (2010). Cognitive load theory, educational research, and instructional design: some food for thought. *Instructional Science*, *38*, 105–134. https://doi.org/10.1007/s11251-009-9110-0

Juanengsih, N., Rahmat, A., Wulan, A. R., & Rahman, T. (2018). Pengukuran Beban Kognitif dalam Perkuliahan Biologi Sel. *Edusains*, *10*(1), 168–174.

Klepsch, M., Schmitz, F., & Seufert, T. (2017). Development and Validation of Two Instruments Measuring Intrinsic , Extraneous , and Germane Cognitive Load. *Frontiers in Psycology*, *8*(November), 1–18. https://doi.org/10.3389/fpsyg.2017.01997

Klepsch, M., & Seufert, T. (2020). Understanding Intructional Design Effect by Differentiated Measurement of Intrinsic, Extraneous, and Germane Cognitive Load. In *Instructional Science* (Vol. 48, Issue 1). Springer Netherlands. https://doi.org/10.1007/s11251-020-09502-9

Kusuma, R. D., Rohman, F., Syamsuri, I., Biologi, P., Malang, U. N., & Pembelajaran, P. (2017). Permasalahan dalam Pembelajaran Biologi pada Jurusan Pertanian di SMK Negeri 1 Kademangan Blitar. *Prosiding Seminar Nasional III Tahun 2017 Universitas Muhammadiyah Malang*, *April*, 133–136.

Leonard, L. (2015). Cognitive load and Asperger ' s : Teaching relevance. *Journal of Student Engagement: Education Matters*, *5*(1), 12–17. https://ro.uow.edu.au/jseem/ vol5/iss1/3

Mayasari, N. (2017). Beban Kognitif dalam Pembelajaran Persamaan Deferensial dengan Koefisien Linier di IKIP Bojonegoro Tahun Ajarana 2016/2017. *Jurnal Silogisme : Kajian Ilmu Matematika Dan Pembelajarannya*, *2*(1), 1. https://doi.org/10.24269/js.v2i1.507

Nurismawati, R., Rahmat, A., & Siahaan, P. (2021). Writing is Thinking as A Strategy Against Students' Extra Cognitive Load In Light and Optics Online Learning. In *Pedagogical Innovations in Education* (pp. 107–113).

Putri, I. I. (2018). Hubungan Komponen Usaha Mental (UM) dan Menerima Mengolah Informasi (MMI) pada Proses Pembelajaran Biologi. *Bioilmi*, *4*(2), 53–61.

Putri, I. I., & Ferazona, S. (2019). Analisis Usaha Mental (UM) Mahasiswa sebagai Gambaran Extranous Cognitive Load (ECL) dalam Kegiatan Perkuliahan Pendidikan Biologi. *Perspekstif Pendidikan Dan Keguruan*, *X*(2), 67–72.

Rahmat, A., & Hindriana, A. F. (2014). *Beban Kognitif Mahasiswa dalam Pembelajaran Fungsi Terintegrasi Struktur Tumbuhan Berbasis Dimensi Belajar*. 66–74.

Raida, S. A. (2018). Identifikasi Materi Biologi SMA Sulit Menurut Pandangan Siswa. *Journal Biology Education*, *1*(2), 209–222.

Scharfenberg, F. J., & Bogner, F. X. (2013). Teaching Gene Technology in an Outreach Lab: Students' Assigned Cognitive Load Clusters and the Clusters' Relationships to Learner Characteristics, Laboratory Variables, and Cognitive Achievement. *Research in Science Education*, *43*(1), 141–161. https://doi.org/10.1007/s11165-011-9251-4

Sweller, J. (1988). Cognitive Load During Problem Solving: Effects on Learning.

*Cognitive Science*, *285*, 257–285. http://onlinelibrary.wiley.com/doi/10.1207/s15516709cog1202_4/abstract

Van Merriënboer, J. J. G., & Sweller, J. (2010). Cognitive load theory in health professional education: Design principles and strategies. *Medical Education*, *44*(1), 85–93. https://doi.org/10.1111/j.1365-2923.2009.03498.x