Graphic organisers as scaffolding for students' revision in the pre-writing stage

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Writing is a complex process. Scardamalia and Bereiter (1987) categorise poor and expert writers according to the type of writing they do. Poor writers are likely to use the knowledge telling strategy where students think and write whatever comes to their mind. Their writing reflects their train of thought rather than an understanding of the train of thought of the reader. Expert writers however, use the knowledge transforming strategy. They show an awareness of an overall plan or goal which they develop within the problem constraints given to meet their readers' needs. Graphic organisers have often been used to help students plan their writing but not to revise their writing in the pre-writing stage. Based on the premise that students can revise better if they can see better what they are revising, this paper provides the theoretical underpinnings to show that graphic organisers could be useful revising tools in the pre-writing stage and guidelines on the effective use of graphic organisers as revision tools in multi-draft pre-writing.

Keywords: pre-writing, graphic organisers, revision, scaffold

Introduction

Writing is a complex process. Scardamalia and Bereiter (1987) categorise poor and expert writers according to the type of writing they do. Poor writers are likely to use the knowledge telling strategy where students think and write whatever comes to their mind. Their writing reflects their train of thought rather than an understanding of the train of thought of the reader. Expert writers however, use the knowledge transforming strategy. They show an awareness of an overall plan or goal which they develop within the problem constraints given to meet their readers' needs. Graphic organisers have often been used to help students plan their writing but not to revise their writing in the pre-writing stage. Based on the premise that students can revise better if they can see better what they are revising, this paper provides the theoretical underpinnings to show that graphic organisers could be useful revising tools in the pre-writing stage and guidelines on the effective use of graphic organisers as revision tools.

The following sections first look at the revising process of expert and poor writers and then considerations that need to be taken into account in the use of graphic organisers as a revising tool in multi-draft pre-writing.

Revising process of expert and poor writers

The following discussion provides more insights into the types of revisions expert and poor writers make in text during the writing stage (Table 1) and an explanation for their revising strategies. The discussion also acknowledges the link between reading and writing skills as students' reading skills influence their ability to revise in the textual modality, that is, students will be able to revise better if they can see better what they are revising (Tierney & Pearson, 1984; Stotsky, 1984).

Table 1: Revising process of expert and poor writers

Expert writers	Poor writers
Organise and chunk information and use a perceptual pattern to hold information.	Do not chunk information. Impoverished understanding of relationships among facts.
Diagnose the problem; More global revisions – precedence or density	Detect and rewrite the problem - more local revisions
Flexible processing - top-down and bottom-up processing	Fixed processing strategy, decode words, use default interpretations

Clarke (1990) states that expert writers are able to chunk information and use a perceptual pattern or general schema to hold information. Flower, Hayes, Carey, Schriver and Stratman (1986) agree that

expert writers are able to recognise patterns and tend to see revision as a whole-text task. Their ability to categorise problems enables them to call up relevant past experience and specialised knowledge from long-term memory to resolve the problem.

On the other hand, poor writers do not have a schema to hold information. Thus, they mainly rewrite their text when revising (Flower, Hayes, Carey, Schriver and Stratman, 1986). Anderson and Pearson (1984) agree that poor readers have an impoverished understanding of the relationships among the facts they know about a topic and are unlikely to make inferences required as they do not chunk their information.

In addition, expert writers are able to diagnose writing problems so that the problems could be resolved while poor writers cannot. Hayes, Flower, Schriver, Stratman and Carey's (1986) study find that although expert writers only detected 58 percent of the "planted" problems, their revisions showed that 91 percent of these problems had disappeared. They explain that this is because expert writers follow either one of two revision rules: precedence or density. In terms of precedence, if they discover a global problem, it becomes a priority for revision. All other local revisions will be seen in the light of the revised version of the global problem. In terms of density, if a lot of problems surface, expert writers are willing to do a complete rewrite of their text. Flower, Hayes, Carey, Schriver and Stratman (1986) also add that when revising, expert writers can choose to ignore, delay their writing as they search for more information, revise the problem or rewrite the text completely as they are more concerned with resolving the problem.

Poor writers on the other hand, can detect writing problems but not resolve them. Chi, Feltovich and Glaser (1981) explain that novices' schema has sufficient elaborative declarative knowledge but lack abstracted solution methods. In other words, they can identify the key features in the problem statement but are not able to infer further knowledge from literal cues in the problem statement. Thus, poor writers tend to revise at a micro level by rewording or paraphrasing writing problems they detect (Paulus, 1999).

Lastly, expert writers possess a variety of declarative and procedural knowledge to help them overcome their writing problems (Richards, 1990). Thus, they have very flexible plans and are willing to shift direction once they discover a better alternative to help them achieve their goal (Zamel, 1983). Adams (1980) adds that expert readers use top-down and bottom-up processing as complements rather than substitutes for one another. Top-down processing or conceptually–driven processing is a strategy where the individual proposes possible inputs and then determines whether or not these occur in the input data. Bottom-up processing or data-driven processing is a strategy where the particular pattern of processing is determined primarily by the stimulus properties of the input data (Rumelhart, 1977).

Poor writers, on the other hand, have very inflexible plans as they do not have enough declarative or procedural knowledge to help them generate enough ideas to write. Richards (1990) mentions that novice writers often focus on decoding single words and seldom look ahead or back in text to monitor and improve comprehension. Phillips (1988) adds that low proficiency readers often assumed default interpretations and withheld or reiterated information. Therefore, they are very unwilling to discard anything that would fit into the topic.

Reasons why graphic organisers may be a viable choice in scaffolding revision

Graphic organisers may be a viable choice in scaffolding revision for the following reasons.

Perceptual properties

The perceptual properties of computational offloading, re-representation and constraining may help students to see better what to revise. Organisers such as the tree diagram, fishbone and matrix provide these perceptual properties as opposed to organisers such as spider map and venn diagram which do not provide these perceptual properties. The perceptual properties differentiate these two types of organisers by their ability to provide a clear categorisation of ideas into main ideas and sub-ideas, with the relationship between the ideas made explicit and ideas easily located (Figure 1).

Computational offloading refers to "the extent to which differential representations reduce the amount of cognitive effort to solve informationally equivalent problems" (Scaife and Rogers, 1996, p. 188). Diagrams promote computational offloading as it indexes information by location. Robinson and Skinner's (1996) study support the facilitative advantage of graphic organisers (text vs. outline vs. matrix) in locating information. In their first study of 44 undergraduates, they find that outlines or matrices facilitate local search because when one relevant fact is found, the next relevant fact will most likely be

located next to it. This greatly reduces the amount of mental resources needed and the errors made. In their second study of 43 undergraduates, students who search matrices are able to answer comparison questions more quickly than those who search outlines or texts. Matrices facilitate global search because of their computational efficiency (easy to find several pieces of information and maintain them in working memory) rather than search efficiency (easy to find one piece of information).
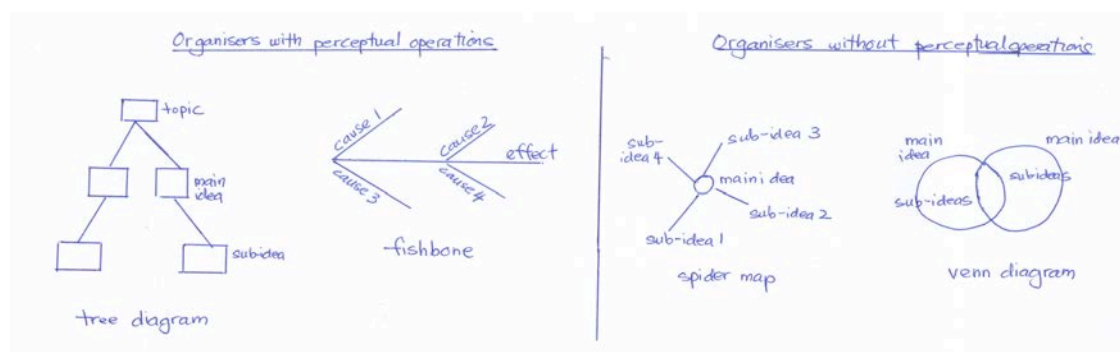

Figure 1: Organisers with and without perceptual operations

Another property that sometimes makes diagrams effective is re-representation. This refers to "how different representations that have the same abstract structure make problem solving easier or more difficult" (Scaife and Rogers, 1996, p. 189). Suthers and Hundhausen's (2003) study on 60 undergraduates looked at the influence of three different representations (matrix, graph and text) on collaborative learning processes and outcomes. They find that the extent to which learners will discuss evidential relationships can be influenced by the extent the representation prompts students to consider those relationships. Their findings show that matrix and graph users have more discussions on evidential relations than users of text. In addition, users of the matrix had the most number of discussions on evidential relations but over-prompting by the matrix drew students' attention to irrelevant relationships in the matrix. Users of the graph on the other hand, were more focused in their discussion of evidential relations and this had the most impact on the content of their essays. In addition, Guri-Rozenblit's (1988) study of 256 undergraduates find that tree diagrams help significantly when students lack background information. She finds that students recall significantly the sequential relations in a multi-thematic text that is new to students. In addition, the tree diagram decreases significantly the rate of order mistakes in presenting the sequential process of communication and marketing and the listing of wrong elements.

The third property that sometimes makes diagrams effective is constraining. Scaife and Rogers (1996) refer to constraining as "the way graphical elements in a graphical representation are able to constrain the kinds of inferences that can be made about the underlying represented world" (p. 189). Constraining limits the kinds of interpretations that can be made from a diagram as each representation is constrained by its form as to the information it can convey. In other words, constraining guides inquiry and learning by limiting the size and complexity of search space.

Organise and chunk information

Graphic organisers also help students revise better because they help them to organise and chunk information. Alvermann's (1981) study on 114 tenth grade students find that they recalled significantly more in the description passage condition rather than the comparison passage condition because the structure of the graphic organiser (purposely structured to match the text structure of the comparison version) did not match the top-level structure of the descriptive passage. The graphic organiser may have influenced the students' assimilation encoding process by providing anchoring ideas to help hold incoming information from text that is not consistent with the author's text structure until that information can be reorganised or forced the individual to analyse and attend to semantic content more deeply to match the author's top-level structure.

Diagnose and resolve

Graphic organisers may also help students to resolve the problem once they have been diagnosed as students can see clearly the relationship between the main ideas and sub-ideas. This facilitates categorisation of the problems when they are detected, enabling them to focus on the problematic features that matters. In addition, ideas in the graphic organisers are in keyword format. Thus, students do not have to worry about the expression of their ideas in sentences. This enables them to focus on meaning revisions using the graphic organiser.

Overview for flexible processing

Collins, Brown and Larkin (1980) mention that the text-based view of inference is linear in nature and looks for meaningful relations between different propositions in the text while the model-based view is able to highlight the important ideas in the text visually and spatially. Hegarty, Carpenter and Just (1991) add that diagrams can provide readers with spatial representations that are often difficult to derive from text because they enable readers to reorganise information in new ways. Armbruster, Anderson and Meyer's (1991) study on 365 fourth and fifth graders find that graphic organisers provide students with an overview of what they are presenting which is useful to facilitate flexible processing. Their study shows that the use of a graphic organiser (frames) helps students to select important information and to organise the information into a coherent mental structure. This is because frames reflect important information in the text and the ideas in the frames are indexed by location and thus the relationship between the ideas can be seen more clearly.

Advantages of revising using graphic organisers in the pre-writing stage

Revising using graphic organisers is more advantageous in the pre-writing rather than writing stage because firstly, it reduces students' cognitive load if content revising is conducted free of the demands of constructing well-formed and coherent text. With a reduction in cognitive load, students can concentrate on "comparing, diagnosing and operating" (Flower and Hayes, 1981) what they want to write to the rhetorical problem they are trying to answer.

In addition, revising in the pre-writing stage would provide students with a clear mental representation of their writing plan and lead to better essays. Chai (2006) finds that there seems to be a positive association between the quality of writing plans and essay scores. She assessed the writing plans of 2,374 students written for the 1998 Provincial Assessment of Writing for grades 4, 7 and 10 in terms of association, arrangement, levels of response and elaboration. The results show that the quality of students' writing plan is positively related to their essay scores. Plans which are organised and structured; and have initial and intermediate level of responses have higher mean essay scores while plans which are well elaborated, including a brief summary of topic have the highest mean essay scores.

Considerations in the use of multiple graphic organisers as a revising tool in multi-draft pre-writing

The use of multiple graphic organisers in this study refers to students having the option to use the same type of organiser or different organisers throughout the pre-writing stage. The considerations that need to be taken into account in the use of multiple organisers in a multi-draft environment is discussed following Ainsworth's (2006) conceptual framework for multiple representations, which consists of three elements: design, function and cognitive task.

The design parameters are namely, number, form, information, sequence and translation. Ainsworth suggests that the number of representations should be just sufficient for the task as the cognitive tasks involved in using the representations are complex and students need to be trained to use them well. In terms of form, students have to understand how ideas in the organisers are related to each other to be able to use them correctly. This is important because Schnotz and Bannert (2003) have found that task-inappropriate graphics may interfere with mental model construction. Furthermore, students need to be informed about the way the information is distributed in the sequential or concurrent representations so that they will be able to make wise choices when they translate information between representations from one modality to another.

Ainsworth also recommends that we should identify the function of the representations to see if they are complementary, constraining or constructing when providing support for processing. She explains that recognising the functions of the representations is important as it determines whether the representations have to be co-present when information is processed. If the representations have to be co-present, this will involve a higher cognitive load. The multiple representations complement each other when they differ in terms of the processes each supports or the information contained. The constraining function happens in two ways: when a familiar representation is introduced prior to an unfamiliar one so that students can learn by analogy, and by explicit illustration. Lastly, multiple representations have the constructing function when learners integrate information from the various representations introduced to construct new knowledge that would be difficult to achieve with only one representation.

In terms of cognitive load, the writing task can be broken down into smaller writing processes (or sub-tasks) so that students can concentrate on one sub-task distinctly before going on to the next sub-task. Pollock, Chandler and Sweller (2002) proposed an isolated-interacting elements learning approach where learning elements are introduced in isolation in the first phase before being introduced simultaneously in the second phase. This could reduce the intrinsic cognitive load, which refers to the difficulty of the material to be understood. Students can also have the option to switch to another organiser, which may be more appropriate to the nature of the sub-task. For example, the first sub-task may be procedural in nature while the subsequent sub-task could be causal in nature. With the use of multiple organisers, students can switch from using a flow chart, which reflects procedural relationships better, to a fishbone, which reflects causal relationships better.

Secondly, although having to process information in more organisers results in an increase in extraneous cognitive load, the complementary and constraining functions of the organisers and feedback can offset this. Extraneous cognitive load refers to the cognitive load imposed when students engage in activities that are not directed at schema acquisition or automation. One example of extraneous cognitive load is when students have to process extraneous and redundant stimuli. Mayer (2001) states that these extraneous and redundant elements should be excluded rather than included in learning materials in order to facilitate learning. If the sub-tasks are sequenced consecutively, where the ideas in the sub-tasks are related and cumulative (builds on each other), the redundant ideas in the organisers may be used to the students' advantage instead. The complementary and constraining functions of the sequential organisers can help students to align their ideas at the macro (main idea) and micro (sub-idea) level as they build on ideas in the previous sub-task for the subsequent sub-task. If they find that the ideas generated in the subsequent sub-task are not relevant to their writing goal, they have a reference point to go back to (the previous sub-task) to revise their ideas. This aligning activity facilitates the recursive nature of writing.

In addition, more help can be provided to students when processing information in multiple organisers. One common method to increase students' germane cognitive load (cognitive load resulting from cognitive activities that are relevant to schema acquisition and automation) in writing is to provide feedback. Feedback on students' writing by their peers or teachers helps to scaffold students' revision as feedback provides students with a mental model of readers (Schriver, 1992; Berg, 1999). Thus, students are clearer about the incongruity between their ideas and how their audience perceives the ideas. Feedback also reinforces and expands students' understanding (Witbeck, 1976), as there is negotiation of meaning (Mendoca and Johnson, 1994). In addition, feedback provides students with more exposure to a variety of writing styles (Harris and Graham, 1996) and practice to discriminate between useful and non-useful feedback (Harris, 1992). This helps to build up students' declarative and procedural knowledge and inculcate metacognitive awareness so that they will be equipped to evaluate their own writing in the future.

Receiving feedback on their ideas may also increase students' metacognitive load (cognitive load incurred in monitoring the reading or writing process). The act of revising may prompt students to explain or justify to themselves why they put certain ideas there and how those ideas relate to their writing goal. VanLehn, Jones and Chi (1992) state that when students explain examples to themselves, "they learn better, make more accurate assessments of their understanding and use analogies more economically while solving problems" (p. 1). This is because self-explanations help students to construct inference rules, which would help students to proceduralise the rules into usable skills.

Guidelines affecting the effectiveness of graphic organisers as a revising tool

Research has shown that there are some factors that determine the effectiveness of the graphic organisers. These factors relate to research conducted on the use of graphic organisers in reading; planning writing; and revising in text as there is no research on the use of graphic organisers as a revising tool as yet.

Multi-draft approach

A multi-draft approach will allow students the time to conceptualise the information better. Roundy (1984) finds that revision sessions on drafts-in-progress and peer review are helpful in helping students revise in technical writing. This finding is supported by Ferris (1995) who finds that in a multi-draft setting, students are more likely to re-read their essays as they have put in a lot of effort to write the drafts and to revise according to the commenter's suggestions.

Distribution of information

In a multi-draft approach, care must be taken as to how the information in the representations will be distributed. The type and complexity of the task students are required to perform will usually determine the distribution. Argumentative writing for example, builds one argument on top of the previous argument, thus lending itself to the use of organisers with the complementary and constraining functions. Cause and effect essays on the other hand would lend themselves to the use of organisers with the constructing function. Students have to be informed explicitly about how the information is distributed so that they will be able to relate the information in the organisers with the different functions to their writing goal and audience's needs.

Students' engagement

Research has found that graphic organisers are more effective if students generate the organisers themselves. Simmons, Griffin and Kameenui (1988) find that teacher-constructed pre or post graphic organisers are no more effective than traditional instruction in comprehension (frequent questions and discussion throughout the instruction process) in their study of 49 sixth grade students. This may be because students are being spoon-fed. As they do not have to construct the graphic organiser, they lack processing depth. In addition, the teacher may have assumed different prior knowledge from the students or oversimplified the comprehension process by focusing on basic declarative knowledge of facts.

Berkowitz (1986) also finds that students who study maps do not improve as they are passively looking at someone else's knowledge construction. His study on 99 sixth grade students find that scores for students who construct the map and those who answer questions are higher than those who study the map or reread the text. Students who construct maps score higher on immediate free recall but only for passages where the hierarchy of ideas in the text is explicit. The answering questions strategy however, has a drawback as it does not focus on the text structure. Hence, the recall score for students in that group is lower than those who construct maps.

Training

In order to facilitate proper usage of the organisers, training in the use of graphic organisers is important. This is because students may not recognise the usefulness of graphic organisers and may not know how to apply them meaningfully. Chmielewski and Dansereau's (1998) study on 60 undergraduates find that knowledge map training helps students to recall more macro level ideas than students not trained in the construction and use of the knowledge map. This may be because training on the production and processing of knowledge maps helps students to develop a top-down learning set. Thus, students may find it easier to learn new information because they can reduce cognitive demands by treating the information hierarchically (Ellis, 2004). Top-down processing helps students to separate what is important to know from irrelevant information, consolidate information and identify main ideas and supporting details and make decisions about the best way to structure the information.

Brookbank, Grover, Kulberg and Strawser (1999) also support the role of training. Their students from various grades in three elementary schools and one junior high school were introduced to 30 different types of graphic organisers stretched over a period of 16 weeks, with the intervention introduced once every four weeks. They find that students improved in comparing and contrasting information, sequencing events, relating parts to wholes, classifying information, making analogies and in their writing. Their thinking skills also improved as seen in their use of organisational methods during the activities.

Griffin, Malone and Kamenuui's (1995) study on 86 fifth graders also supports the role of training. They find that students who have explicit instructions on the use of hierarchical graphic organisers perform better on transfer tasks than the control group (traditional instruction). In the absence of explicit instructions, the performance of the students is similar to rereading the text.

Familiarity

Training will thus familiarise students with the form and function of the organisers. Winn (1993) mentions that readers' knowledge of the content the diagram describes lets readers anticipate what to look for next and where to look for it. However, if they are unfamiliar with the graphic organisers and the features of the organisers, their performance will be affected.

Winn and Sutherland (1989) conducted a study on 178 eighth to tenth graders using four concept maps and four circuit diagrams consisting of 8, 12, 16 and 20 features. They find that familiarity and the form of the elements affects the encoding strategy used. However, there is no interaction between form and familiarity or task and no interaction of familiarity with tasks.

Time

Research also shows that training and familiarity in the use of the organisers needs to be built over a period of time. Alvermann and Boothby's (1986) study on 24 fourth graders find that students who have been instructed and used the graphic organisers for 14 days could comprehend and recall significantly more information than students in the control group. However, there was no significant difference between students who had graphic organiser instruction for 7 days and the control group.

Ellis (2004) also feels that students need about 15-20 different meaningful exposures to a specific graphic organiser before they really begin to understand and internalise it. Glover, Bullock and Dietzer (1990) suggest that a longer duration between learning and testing will be helpful because according to the spacing hypothesis, the delay will cause the material to be stored in long-term memory. Hence, students will need to reactivate the material from long-term memory for usage. Repeated activations facilitate easier recall.

Robinson and Kiewra's (1995) study of 111 undergraduates also find that given enough time, students studying graphic organisers (matrix and tree diagram) learn more hierarchical and coordinate relations and are more successful in applying that knowledge. They also write more integrated essays than students studying outlines or the text alone. Mannes and Kintsch (1987) also find that text memory undergoes qualitative changes with delay. Thus, with time, students are more likely to recall concepts than details and the differentiation between prior knowledge and the text itself declines.

Feedback to augment relevant information

In order to augment students' ability to identify relevant information in the organisers, peer and teacher feedback could be given. Scardamalia and Bereiter (1993) asked students to provide comments using these categories: *generate new ideas, improve ideas, elaborate ideas, identify goal and put ideas into cohesive goal* to help them in knowledge building. Ferris (1997) also advices that feedback given should be text-specific, idea-based and meaning-level feedback as these types of feedback are more effective compared to feedback given in question form, statements of information or where problems in logic or argument are presented.

In addition, feedback should be given early in the writing process. Ferris (1995) finds that students are more willing to accept comments on an earlier draft rather than in a later draft when they have already put so much effort into it. McGarrell and Verbeem (2007) also find that formative feedback motivates revision of drafts and provides opportunities for the development of students' writing skills.

Conclusion

This paper suggests that graphic organisers may be a viable choice in scaffolding revision in addition to text because they enable writers to see better what they are revising. However, this ability to 'see' better may be better offered by organisers with perceptual operations as opposed to those without. This is because organisers with perceptual operations differentiate main ideas from sub-ideas clearly and provide an overview of how the ideas in the organisers are related to one another which facilitates categorisation and diagnosis of writing problems in the revision process. This possible advantage however precludes that students must be properly trained over a period of time to understand the form and function of each organiser so that they would not misinterpret the ideas in the organisers when generating or revising ideas in their own organisers or when providing feedback on their peers' organisers.

Considerations in the use of multiple organisers in multi-draft pre-writing have also been presented using Ainsworth's (2006) conceptual framework for multiple representations. The design, function and cognitive task elements of the framework affects the effectiveness of graphic organisers as a revising tool in terms of the pedagogy employed.

In terms of learning technology, students could have various options when revising their ideas in a multi-draft environment. The first option would be where students revise ideas using graphic organisers alone for the various drafts before proceeding to write their essay. Thus, revision here happens only in the

visual mode. In order to aid revision, it would be good if there is a comment box that states the audience's needs and writing goal in each draft. This is to remind students to align their ideas in a goal-directed manner. The second option would be where students generate their ideas using organisers and then write out the essay and then go back to the original organiser to align their ideas with those in their essay, which may trigger more revisions. It is suggested that students generate ideas using graphic organisers first rather than start by writing the essay as the former reduces the difficulty of the task where students only need to deal with ideas compared to the latter where they need to generate ideas and construct sentences simultaneously. In addition, the focus of the translation exercise is to force them to re-consider the structure of their ideas and to deepen the processing of their ideas. An automatic translation between the two modes by any software is not encouraged as then, students will not be engaged in the conceptualisation process and will not notice the incongruities between their ideas and what is expressed in their essays. The second option also offers an advantage to students as sometimes, new ideas are generated when they start writing. Thus, the translation exercise encourages students to see that writing is recursive, where changes happen in the light of changes elsewhere in their writing.

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