2 RQ.No.2 What is effective multimedia presentation ?

Structure of Research Question No.2

Preface as introduction	
1. Explanation about research question No.2	
Preparation	1. Origin of Multimedia presentation based on cognitive theory aiming spontaneous learning
	2 Conflict whether Multimedia presentation contributes enough to education/learning or not.
	3 Weighing which win?

2-1 What is effective multimedia presentation form?	
● Viewing from cognitive science	
	1 Demystifying the major source
	2 Conflict whether the source is reliable or not.
	3 Weighing the conflict and the application
● Viewing from Information Design ~practical use~	
Based On The theory	1 Demystifying the major source
	3 Conflict whether the source is reliable or not.
	3 Weighing the conflict and the application

2-2 What is effective multimedia presentation customizing individual difference?

1	Origin of Individual difference
2	Conflict whether Multimedia presentation customizing individual difference contributes enough to education/learning or not.
3	Weighing which win?
4	Who gets most fruitful result from multimedia presentation?

1 Explanation about research question No.2

Again, I clarified why the way of presentation of multimedia material matters. It is because software can get its life only when the software is provided for learners with both thoughtfully designed presentation and concepts. Which collaboratively cause active-interaction of learners with provided information by softwares. So the good interaction design is needed which enable learners to easily take in information with computer-display and human interaction. And these days, research papers gradually appear which deal with the way of computer-play and human interaction. So I summarize the recent research, organizing information into two groups,

1 **Productive way of adding pictures to text and narration** (Mayer's source)
Effective design format of picture and words
(Information design and other source)
2 **For whom, graphical or multiple presentation is effective?**

2-1 What form is effective?

~Viewing from both field of
educational technology and Information Design~

Introduction ~ purpose of this chapter~

~Dividing two, Desirable multimedia presentation design viewed
1)from cognitive theory
2)from practical use

As you see sub title, here, I propose desirable design based on the field of educational technology and information design.

In the field of educational technology, among any presentation design of multimedia, It deals with the presentation which seems desirable, viewing from cognitive and psychological aspects..

While In the field of information design, it deals with desirable presentation which seems practically useful.

So I will summarize the desirable multimedia presentation dividing two topic, one is the good design for cognition and mind(researchers belong to the domain of education.). And the other is good for practical use(Writers belong to the field of information design and business).

2 -1 Basic Principles of effective multimedia presenation Based on cognitive theory

1 Preparation of argument;

First, I introduce the topic “Design based on cognitive theory”.

Results from this topic are all about “**productive way of adding pictures to words”**.And the presentation principle are answers to the question below.

1) **What kind of pictures should be added?**
2) **When should they be added?**

Analysis of transition of idea over history; See Figure 1

In old time, evidence-based audio-visual presentation did not exist. Old audio-visual presentation is things for showing the possibility of fun lesson with new technology.(projecter,film)

In middle time, Experiment’s result-based audio-visual presentation appeared. Research interest’s changed from visual presentation into learning, thinking and communication. Roger(1976) showed the relationship between creative scientists and visual imagery. So there was several experiment based on the premises that visual imagery cause good educational effects. For example, “Imaginarium” that is space eliminating external stimuli in order to increase one’s awareness towards mental imagery.. Individual difference(relative dominance of verbal or visual, or left or right) was measured by EEG recoding.

And some principle of visual presentation. BIkkar imply the imporatance of further research of visual presentation adjusting individual learner’s style.

As you see, until recent, there is no design principle based on the scientific evidence. so the most of source I use is the recent source based on scientific experiments.

History of Idea Model; Visual / Verbal representation in learning

Figure1

	Old(~1970)	Middle(1975~1989)	Recent(1990~)
Research Question	What is effective way to use visual method in Education? Sumner (1956)	What is visual learning, visual thinking and visual communivation? And which cause what good effect ?	What is the design principle of multimedia learning based on scientific research?
Method	Literature review of every definition of visual methods. And making ideal model lesson	● Literature review and retention and transfer test ● EEG recording ● Imaginarium	Statistical experience which prove paper-theory whether it works or not.
Cause Of Visual effect	History(Altamira,visual sign system) show The importance of visual Repreentations.	Experience of retention and transfer test show such results But consideration of reason remain unsolved.	To minimize cognitive load of working memory is effective to Retention and Transfer.
Result		●picture are learned better than word but its speed of presentation rate should not be too fast. Concept learned by picture tend to be broad and abstract. The researcher imply the importance of the relationship of learner's style.	1) Integrated design is more. 2)Less is more. 3)Strong cause-and-effect Is basic rule of content design. 4) Pointing is more effective than non pointing. 5)complex thing is better presented in visual
Field Aim	To address the effectiveness of visual method in education for bringing out spontaneous learning.	To theoretically clarify the role of visual thinking, learning and communication, wishing further development of the field which hold many unsolved problems	To propose the design principle based on the evidence for the designer who treat both verbal and pictorial.
Social Context Of Each Era	In this era, children are regards as passive in learning. So perhaps, some educators would try to bring out spontaneous motivation to learn. So audio-visual is regarded as one of new strong device for bringing out student's interests. So they propose interesting model lesson like big map game, exhibition to learn words, touching objects.	Some researcher criticized verbal-dominant way of teaching.Western civilization has overemphasized the left-hemishere functions, depriving the right. When dealing with visual material, it is over-simplified. It implies that some educational system tend to regard non-verbal side of our mind as meaningless or useless. Arendt(1977) implied that solution to passive learning is Creativity.	● In spite of importance of Visual presentation, scientifically supported theories are few so recently such scientific research began to appear. ● visuo-spatial talent of dyslexia or other special children began to be claimed now. ● The relationship Between creativity and visual thinking is proved by Genius examples.

Demystify the major source

Strong point of major source

Major source is “Multimedia Learning” by Richard E.Mayer (2001) and “Multimedia learning : cognitive and instructional issues” by Jean-Francois Rouet, Jarmo J. Levonen and Agnes Biardeau(2001). Because both results are supported by empirical and statistical evidences. Richard E.Mayer introduced one con-position per each pro-position. And as a result of empirical experiences, all pro-position won.

Though it is weak only to introduce one con-position called “Information delivery theory”. And this theory is uncertain in the respects which does not clarify by whom, and when it is claimed. He did not clarify the origin of information-delivery theory. So I’m not sure, but I guess the origin of information-delivery theory from other source.

So I add the background information to information-delivery theory. And I also clarify the essential per-condition’s difference cause a contradiction between information-delivery theory and multimedia learning principle.

Information delivery theory
Guess Information delivery theory might points out the advocate who is satisfied with computer-aided-learning with drill training or a lot of stimuli(music, text, illustration and animation). Which provide a number of quizzes or media to learners, ignoring what is goal that learner should acquire. That is, they ignore the value of spontaneous learning, they just give information. And the advocate of spontaneous learning is based on “Constructionism”, which is common premise of “learning” among today’s educational technologists. **Evidence(Source)** In 1986, John Self criticize the educational software quality.The victim targeted is the software just giving information. So it is certain that there are advocates of information-delivery theory among educational technologists and teachers.

- Contradicted point is the definition of “learning” whether putting importance on spontaneous knowledge acquisition or not. See Figure.1. Configuration of this book is summarized.

Weighing strong point and weak point; Strong point win

I apply Mayer's source as useful one. Because current educational technologists tend to put the heavy importance of program, software itself which enable learners to spontaneously construct their own knowledge with making hypothesis , designing experiment and observing simulation. But they ignore the design effect of interface or interaction between human and computer which help and enable learner to take in new information from computer and constructing meaning and knowledge as *one* pleases. Presentation design principle directly contributes to learner's information take-in, information-digest, meaning-construction from information, and expressing their thinking.

So one composition seems weak, but role of composition in his book is to introduce opposite definition of "learning" to current common paradigm of "learning" among educational technologists and educators. That means that he wants to emphasis the importance of considering the presentation effect, if the educational software developer or web-page developer really want to bring out spontaneous knowledge acquisition of learners. As long as learning based on knowledge acquisition is the common paradigm of educational technologists, they should consider the presentation effects. So one con-position in the book is to strongly emphasize on the information design effects. And the weakness of one is made up with statistical evidence and pro-positon.

- **Summary of all principles; See Figure 3~5**

Reducing burden of working memory as minimum as possible

The same result from old----Presenting visuals emphasizing relevant and critical details is effective while arbitrarily adding visuals does not increase learning at all. A lot of visuals for expecting motivational effects isn't effective.(Jong et al,1998)(this is the same result of 1950(Sumner))

Whish is consise annoted illustration is the building blocks of effective book-based multimedia presentation. The concept is same but recent researches take practical use in consideration.

- **Warning when using pictorial presentation; Solution is image with several level of explanation to avoid misinterpretations of image**

Illustration is attractive like movie star but which could result in little understanding if it is image of complex content. As long as only one message of title or name of illustration is memorized. Problem is lack of sufficient explanation Pierre Clement(2001)

		Input	Congiguration	End
	Multimedia Principle	**Common Input** **A** Paivio's ***dual-coding theory*** (Clark & Paivio, 1991; Paivio, 1986), **B Cognitive load theory** (Chandler &Sweller, 1991; Sweller, 1999) **C The limited capacity of Working memory** (Baddeley;	**Proposition**	**Multimedia Instruction Theory based on Because empirical evidence based on "Learning as Information acquisition" is out-dated. "Learning as knowledge construction" are proved.**
Contiguity Principle **Graving Information by one sight is good**	**Spatial Contiguity Principle**			
	Temporal Contiguity Principle			
Modality Principle **Less is more theory**	**Coherence Principle**		**Contradiction**	
	Modality Principle			
	Redundancy Principle			
	Individual Differences Principles	**B Dual coding Theory** (Clark & Paivio, 1991; Paivio, 1986)		

Figure1; Abstract structure of Mayer's source(Detail is in Figure 2)

2 Three common original theories which supports 99% Pro-position

A: Paivio's Dual-coding-theory	B: Sweller&Chandler's Cognitive load theory	C:Baddeley's Limited capacity of working memory
Two separate though connected psychological systems of storing and retrieving exist, one for verbal stimuli and one for pictorial stimuli.	Each channel has limitation processing capacity. "Intrinsic" cognitive load become high when many elements and relationship is complicated. While extrinsic cognitive load become high when instructional message is complicated.	This is a more specific model of working memory compared to a general working memory as temporary storage. Specific model includes a distinction between a ***visuo-spatial sketch pad*** processing visual and a ***phonological loop*** processing audio.

No.1	Pro-position **Theoretical support**	Con-position	Empirical Result	Practical Application
Integrated verbal and Visual is better than single	Effectice size of **working memory** can be increased by presenting information in a mixed(auditory and visual) rather than a single mode.	**Information delivery theory**	**Multimedia Principle** Students learn better from words and pictures than from words alone.	On screen animation, slide shows, and narratives should involve both written or oral text and still or moving pictures. Simple blocks of text or auditory only links are less effect than when this text or narration is coupled with visual images.
Graving Info by one sight is good Contiguity Principle	When corresponding words and picture near each other on the screen, learners can hold them both in **working memory** at the same time.	**Information delivery theory**	**Spatial Contiguity Principle** Students learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.	When presenting coupled text and images, the text should be close to or embedded within the images. Placing text under an image (i.e., a caption) is sufficient,but placing the text within the image is more effective.
	When corresponding potions of narration & animation are presented at the same time, learners can hold them both in **working memory** at the same time.	**Information delivery theory**	**Temporal Contiguity Principle** Students learn better when corresponding words and pictures are presented simultaneously rather than successively.	When presenting coupled text and images, the text and images should be presented simultaneously rather than sequentially When animation and narration are both used, the animation and narration should coincide meaningfully

Figure2; Summary Matrix of the source about Principles of Multimedia presentation design

No.2	Pro-position **Theoretical support**	Con-position	Empirical Result	Practical Application
Modality Principle **Less is more theory**	Extra material makes the resources in working-memory overflow and can divert attention from the important and	**Arousal theory** Weiner(1990,1992),Kitsch(1980) Better learning occur when student are emotionally aroused by material.	**Coherence Principle** Students learn better when extraneous words, pictures, and sounds are excluded rather than included.	Multimedia presentations should focus on clear and concise presentations. Presentations that add “bells and whistles” or extraneous information (e.g. to increase interest)
	When picture and words are Both presented visually, the visual channel can become overloaded.	**Information delivery theory**	**Modality Principle** Students learn better from animation and narration than from animation and onscreen text.	Multimedia presentations involving both words and pictures should be created using auditory or spoken words, rather than written text to accompany the pictures.
	When picture and words are Both presented visually, the visual channel can become overloaded.	**Information delivery theory**	**Redundancy Principle** Student learn better from animation and narration than from animation, narration,and on-screen text.	Multimedia presentations involving both words and pictures should present text either in written form, or in auditory form, but not in both.

Summary of features of concise narrated animation	**Summary of features of concise annotated illustrations**

Figure 3;Summary of presentation principle; copied from Mayer(2001),”Multimedia Learning” p192

No.3	Types of sequence	Hypothesis	Empirical Result	Practical Application
Sequential display effect **Better effect come from ordered dispkay?**	**Three major congigurations** **1 A functional hierachical Strategies** Where items were clustered according to their functional properties(ie;Semantic criteria for the library) **2 A spatial hierachical strategy** Where items were clustered according to their spatial properties and mainly internal symmetries. **3 A linear horizontal strategy** Where items were displayed line by line, from left to right and top to bottom.	The sequential display of pictures affects the segmentation of a picture of memory. So the sequential display will guide the reader's processing of the picture, So is the related text with the picture. **Support the hypothesis** Learners are influenced by the order(sequence) of text description when drawing spatial environment or they are influence by the format of the map.(Dnis&Cocude,1992 ;Denis&Denhiere,1990))	First, result show that sequential displays did not lead to better memory performance than the static display. But subjects tend to organize information with presented pattern of display. And they learn to quickly respond to the pattern of display which they use. So this result reinforce the hypothesis that the sequential display of pictures affects the segmentation of the picture in memory, like recognition of task, hierachical analysis on recall orders.	Sequential display may be used to support learning in two ways. 1 One is to reinforce the spontaneous organization of items. Unexpected design is never result in paying attention from learners. So It is good for learner to organize the cluster of semantic meanings with their-preferred sequential display. 2 The display which does not match their preferred style would be used for expressing not so important information in not-stand-out way. **Summary;** Allow learner organize cluster of information on their own way.

Figure4; Summary of sequential display effects

Source; the book "Multimedia Learning,cognitive and instructional"(2001)

	Types of agent	Theoretical support	Empirical Evidence	Practical Application
Agent effect **Pointing out reduce cognitive load**	**Animated agent personalized** An agent delivering non-verbal cues(eg;gesture,gaze, voice, a personalized language style) fosters learning than non-personalized agent delivering monolougue-style.	**Social-cue hypothesis** The reason seems that the extra emotional cues which voices carry and text lacks, promote richer processing by the incorporation of the additional attitudes and beliefs that are attached to the agent (Reeves & Nass, 1996).	Moreno found that learners presented with pedagogical agent who communicated with the students using instructional conversations outperformed their peers of text-based on transfer problem. And reported higher levels of motivation and interest.	In a constructivist science lesson where students learn with the help of a pedagogical agent, the agents' voice and conversational style play a fundamental role in the promotion of meaningful learning.(Mayer,Moreno,1999)
	Animated flash non-personalized ● Procedure of simply flashing pointing device which points out appropriate parts of the pictorial information, when they were described in the spoken narrative, was as effective as a full animation. ● Text-to-speech engine is Effective only in short period of time.	**Reducing Working memory load** By using gesture and gaze to guide leaners' attention to the relevant material, these non-verbal cue reduce burden of leaerers' limited working memory resource. Without agent , voice-only or text only environment, learners are occupied with searching the learning environment	● Flashing pointing device result in equivalent effects. (Scotty D Craig et al,2002) ● This result is opposite from Moreno, but in a short time,Text-to-speech-engine can also perform good but in a long time, its synthesized monotone style become difficult to listen to. (Atkinson,2002)	● Simply flashing sudden-onset has more practical use than full animation. Because creating flasing elements in a static picture can be less taxing with modern technology than creating full animation. (Scotty, Barry, and David,2002) ● we can use agent voice type, accommodating with its purpose and time.

Figure5; Summary of Agent effects; Source is from Atkinson and Scotty(2002) and Moreno and Mayer(1999)

2 -2 Basic Principles of effective multimedia presenation Based on practical use-information Design

1 Preparation for argument;

- **The same part of information design with Multimedia Learning**

First, I clarify why I borrow effective design principle from information design.
It is because that the goal of information design is similar to the goal of multimedia presentation aiming pedagogical effects. Information design put its emphasis on two interrelated concepts, Edification and Commutativity. Edification is personal enlightenment, and Commutativity is the process of mutual change. That is, this the field aiming not just pressing information which users don't want but developing interaction of idea and enlightening.
(Jacobson,1999)

- **Different part of information design from multimedia presentation**

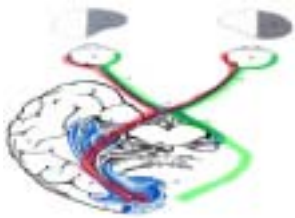
The unique principle come from information design is to put its emphasis on way-finding of information it is needed for "decision-making". So old cliché "less is more" does not mean the quantity but eliminating extra-information preventing users from reaching needed information.

Practical suggestion for Multimedia presentation deducted From information design principle

To realize self-directed learning, how should I design multimedia presentation?

Learning is best when learners.....	Apply to the design for multimedia learning
are active	Have users apply information for themselves, rather than just read about it
Have specific goals	Help users from and refine goals. Suggest goals by showing what users can do with a product.
Value the information	Make information available the moment the user wants it (On-Demand-Training) Show users why information is important. Relate it to real-world problem.
Take responsibility for learning	Let learners initiate training. Tell them they are responsible. Avoid design that puts the user in a passive role.
Feel in control	Let users control what and when they learn. Let users select among short lessons.
Continually leaern	Design learning as a process and not an event.Make training continuously

- Principle of words design

Practically desirable design proposal	**Why it is practical?**
Keep the quality of sound rather than visual Keep the quality of verbal sound good rather than keep the quality of full-animation.	Researchers of MIT's media lab found that the combination of good still images and clear sound work as well as or betther full-motion video. (Apple computer,1992,"Demystifying multimedia)
What kinds of words should be added to Multimedia file? **Limiting information chunks within the number of 4 to 7 chunks** Information should be broken into smaller blocks. **Message topic should be short, independent, self-contained topics than can be read in the order selected by users.** To make topics coherent, 1)Answer one question or about one subjects for one purpose.	Most people can hold only 4 to seven discreet chunks of info in short term memory. Computer screens inhibit predictability in reading, because users must remember context of information, without visually seeing that context. This result is consistent with research by USA Today on its reader habits and concepts (Yale Style Manual for web site design)
Outcome Tendency ● People don't care the edges of screen. ● People tend to pay attention to slightly left side of central and slightly up side of middle. So subject should be designed within the position according to what teacher want to focus language or image.	**Context of Computer Screen design** Screen is rectangle which is long from side to side. So putting which position has noticeable effect on attention, whether left or right. Up and bottom isn't much matter. People see left side with right brain and see right side one with left brain.
Kanji is processed in right hemisphere and kana is processed in let hemisphere. So place Kanji in left side of display and Kana in right side of display, it is easy to read. If the placement is opposite, the time delay of perception dis occur.(Yamaguch,et al,2002)	 Green flow⟶ Left brain. Red flow⟶Right brain.
all of it	

- Principle of technical tip

	Why it is practical?
Immediate visual feedback To be contingent on the learner's action, Visual feedback should be immediately	This result is consisted with temporal-contiguity effect.(mayer,2001)
Enable note-taking of existing content Provide ways for users to add their comments and note-taking to the existing content, and as there is needs, those screen should be printed. (William Horton,1994) **Provide learners more than just reading** Allow users to ● **Add links between existing topics** ● **Add new topics and create links to them** ● **Edit or even delete existing topics** ● **Add annotation** ● **Set users copy and print**	Spontaneous note-taking and the high score of exam is corresponded in linear relationship. So screen design which can reflect learner's note-taking is effective fro learning
Provide feedback Use audible feedback for actions in a graphical user interface.	Sound can acknowledge actions by users and report on the status of an ongoing process.
Allow user use colors to make sense of meaning cluster (Tom Byte,1997)	Color effect is especially good for girls when color is added to knowledge representation. (Palma J. Longo,2001) It also speed up searching(Horton,1994)
1)Allow,but do not force users to control the sequence and pace of learning. Give users a choice when and in what order to take lessons. **2)Make it easy for them to skip over the concept they already know.**	1)What order and sequence is good is different in Users. So giving free choice can accommodate with individual difference. It is the best way. 2)Don't irritate users by controlled condition.

- Principle of visual effects

	Why it is practical?
Perceptual clarity and simplicity Design should be like which enable users holistically understand pattern of design.	Designers often misunderstand harmony and balance of design as aesthetic harmony, Harmony and balance come from a clear conceptual framework mapped onto consistent screen.
Use sound to represent things not shown Use realistic sound, which tells where and when a scene takes place.	Sound can help us see in the mind's eye thing not visible on the screen, User can create impression of outside the small window on the screen.
Show smooth and continuous change for Preparation of the viewer for changes	Movements which is unexpected tend to be overlooked. When making animation, prepare the viewer for sudden changes, without it , users can not notice the change.
A balance of visual weight Make balance of the distribution of objects on the screen based on the fuction rather than aesthetic balacne(Hodges & Sasnett,1903)	Balance effect come from perceptual clarity and simplicity of fuction rather than aesthetic harmony.(Tom Boyle,1997)
Picture work best when combined with words but comments should not be omit the cause-and-effect chain of the role of picture.	Comments help users understand the purpose and meaning of picture. In popular magagines, the explanation of scientific picture is often poor so no understanding occur to reader.
1)Simplify online graphics reduce unnecessary feature of graphic. **2)Use only as many colors as necessary to make objects recognizable**	Because online display has flicker, so graphics work well on paper must be simplified for use online.
1)Animation should allow user to start, stop, speed up, slow down, and rever se the action in a dynamic display. **2)Simplify the illustration used in animation**	1)The better animation is, the more freedom for user, in which user can use it only as much as they needs. 2)Because animations are usually played with small window.
	The placement fits human intuitive non-verbal understanding

3-1 For whom, multimedia learning is effective?

1 History of Idea

Old

Importance of visual stimuli

In 1951, Sumner showed the importance of visual presentation. The method is historical review from Altamira to symbol, picture and logical picture like pie graph or diagram. So the target is every students, for all human-beings pictorial expression is effective way to communicate meanings.

Though recent survey still use this method. (Shnotz,2002)

Objection against visual stimuli

Language is chief vehicle of our thinking because when effectively stored in memory is recoded as verbal information before to go permanent memory system.(Travers,1970).

The student tends to passive so there is no effect.

Pictorial material given from the view of the adult's artistic eye. As such they need much interpretaion.

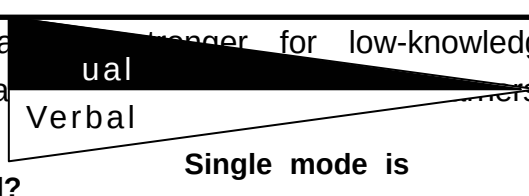
Middle	Recent
Cognitive & learning style Border on dual coding theory, two separate memory channel show up. Students do tend to use information differently as a function of their preferences or style. And subjective preference is connected to academic achievement in non-linear way. So the importance of user's preferred cognitive style is stressed. (Peterson,1996;Bonk&Cummings,1988,Martens,1988,Mirande,et al,1997)	**Individual difference principle** The effects of well-designed multimedia material are stronger for low-knowledge learner than for high-knowledge learners and for high-spatial learners than for low-spatial learners.(Mayer,R,E;2001)
Multiple Intelligence theory Lessons designed by computer from students' pre-test and background data, to meet individual learner's major cognitive style, all students showed positive gain in knowledge acquisition(Coil,Robert,Alan,1998)	Empirical evidence show that Preference for mode is linked to frequency of use of support devices which is opposed to the
Con-position(Strategies for instruction) It is questionable whether one use one's learning strengths and thus neglect the development of other faculities(Jaspers,1992) Pro-position objection(Strategies for learning) Some complex information can be better expressed pictorial way which can hardly be conveyed in words(Jong et al,1998) Constructive friction argument Material fit with their learning style is not necessary a destructive one and It give students a challenge to increase their own learning capability.	Con-position **The old theory turned down by Empirical results.** **Information delivery theory** There is no design's effect to improve learning. Neither is the effect on individual leaner.

Background consistent over time

- **Individual difference of Learning style**

The role of individual difference in learning has long been recognized in educational psychology.(Cronbach & Snow,1997;Jonassen & Grabowski,1993) when a student's preferred presentation mode is not included , that student will have more difficulty in learning.

Learning method matched individual leagers preference
Has good educational effects.
RQ; How to apply these method?



Single mode is dangerous!

The change of Research Question

- **Applying visual to what subject and when is appropriate ?**
- **Applying whom is effective?**

Old → Recent

In old time, Research Question is whether the learning style really does exist or not. And it was proved. So in middle time, the result of applying the individual learning to students was reported.Though, it was not accurate implication of individual learning. So in recent, more specific context is laid down. So the result become more

Outline of this topic

- **Review of History of Idea to clarify the topic I deal with here**

Until now, the research question for individual learner's difference have changed The more scientific research method become, the more specific research question become. So in old and middle time, research is for the sake of experiment whether instruction and material which fit individual cognitive style work or not. In last decade, it is proven that it does work. So recent research question become more specific like in context of what subject, multimedia learning which can meet individual needs does work, or in context of who, multimedia learning does work. Method is mainly based on experiment and its statistical data.

- **Individually Customized Multimedia presentation is effective?**

Pro-position(Preferred learning style is effective)

Advocates are those who make "learning" strategies

The effectiveness of instructional strategies depends greatly on individual learner differences like preferred cognitive style or cognitive capacity(cf;capacity of working memory or spatial ability).

(Peterson,1996,Bonk&Cummings,1988;Martens,1988;Mirande,Riemersma & Veen,1997,Ritchie & Gimenez,1996). That is, material should be accommodated with different learning styles. In this way the learner can generate the necessary relationship between material being presented and their prior knowledge to make learning more meaningful.(Chun,1996)

Pro-Evidence

Several research results confirm the importance accommodated material individual difference because subjective preference is connected to academic achievement in non-linear way.

(Peterson,1996;Bonk&Cummings,1988,Martens,1988,Mirande,et al,1997)

Especially effectiveness of accommodated material for the difference of verbal and visual preference is stressed.(Kirby,1993;Moore & Scevak,1995)

Lessons designed by computer from students' pre-test and background data, to meet individual learner's major cognitive style, all students showed positive gain in knowledge acquisition(Coil,Robert,Alan,1998)

Con-position(Preferred learning style is not effective)

Advocates are those who make “Instructional” strategies

It is questionable whether one use one’s learning strengths and thus neglect the development of other faculities(Jaspers,1992).

Con-Evidence

Preference can be subjective.(Jasper,1992) And the subjective preference is related to a more successful and frequent use of the preferred mode.(Moore & Scevak,1995)Thus studying with preferred learning style in which students can select their favorite learning materials would deprive the learner o the benefit of multiple presentation. Though, the evidence shows the effectiveness of multiple presentations. Active mental connection between different representations of the same information enhances understanding, knowledge acquisition and memorization of learning contents or some promote deeper understanding of domain.(Shonoz)

Weighing con and pro evidence; Pro-position win

This friction between strategies for learning and for instruction can become either constructive or destructive.(Vremunt,1992)

- Constructive argument is that learning material accommodated with learning style is not necessarily a destructive one and it gives students a challenge to increase learning and thinking capabilities, and motivates students to look things from different view. Such material can stimulate their learning activities.
- Destructive argument is that material accommodated with preferred learning style makes students cling to their preferred style and inhibits their learning and thinking.

Weighing these two arguments, constructive argument won; preferred learning style necessarily results in clinging to one’s preferred style.

There is an appropriate media to express each types of information. For example, graphic and symbol is good at expressing complex information or frequency distributions, linear relationships or hypothesis testing.(Jong et al,1988) whereas other information can be easily expressed in a verbal way.

So if teacher could give students appropriate information with appropriate media, Learner would not cling to their own style but select suitable media.

Leaner can understand every method and medium of communication which can contribute to the development of their full potential. They hardly think individual difference as competition showing who’s characteristic is superior as long as

teachers can appropriately guide their pupils. So they don't cling to one's learning style but they freely use appropriate medium to construct their richer meaning. Teachers will tell learners how to use the right learning style for each task to increase their grades and learning abilities. At last, learners themselves, select right medium for rich knowledge acquisition.

Three kind's of properties of individual difference of learners

See figure1, there is a summary what kinds of individual differences exist.
There are 18 learning style, though some are very similar meanings.
Among them, who's learning style can get the most fruitful effects from multimedia learning, the sophisticated design of multimedia presentation ?, in more concrete words, the presentation of graphics and animation.
It is who have not been able to be brought out their talent by traditional teacher media.

- **The people who get the most fruitful effect from interface design**

See the figure 2, Who has the most effective result from multimedia learning and those who can't get it so much. Visual learners with low knowledge can get the best results from multimedia presentation

- **Summary of for whom is effective. to apply multimedia learning to real class room**

Now that we know the more effective learning occur, the more individual element is considered. Next, to apply individual difference to real classroom lessons, The test should be done before implementation of Multimedia Learning, which asses and monitor the student's level of comprehension of the domain and spatial ability and cognitive ability.
Though, here, I don't cover about the test, there are a lot of study in the field of Intelligent Tutoring System about the program and the test for assessing individual difference(student model).
To sum up, these characteristics, Multimedia representation is the most effective for visual learners.(Butler and Maut),That is younger age people who brought up in TV and games. But there is a condition that multimedia presentation should be provided for children older than 10 years old. Because the empirical experience show that children who are younger than 10, don't have enough cognitive skill to integrate meaning from picture and text.(Fransois Guercin,2001)

Three kinds of individual learner ‘s difference(Figure 1)

	Type of Diffrence	Characteristics	Application
1 Properties of learner which influence schlorship	**Personality**	Introvert or extrovert.	Group study→extrovert. Learn with question naturally occurred to the mind.→ Introvert
	Interest	High-interest and low interest , individual diffrence	
	Mental Capacity	Mental capacity is consist of Intelligence and Creativity. The definition of Intelligence is abstract thinking, capacity to learn new and ability to propose appropriate (adapted)solution to a problem. Creativity is a ability to produce novel and valuable(appropriate) ideas.	High IQ but low creativity. Hight IQ and high creativity So-so IQ but high creativity So-so IQ and so-so creativity Like this, learning strategies will differ in the combinations.
	Belief & Value	Self-schema, personal value towards learning, and vision of life	Motivated user learn by exploring related pieces of information. Provide cross-reference links to related lessons and reference material.
	Motivation & Emotion	Likes and dislike and drive of motivation	
2 Properties of Learning style which influence process of learning	**Holist** ↕ **Serialist**	This style come from research of cognitive style. When solving a problem, Holist tends to see the problem as broad as possible and approach to a solution by formulating multiple hypothesizes. Serialist tends to pay one’s attention to detail and then formulate one hypothesis based on rational consistency.	Arrange learning segments in a logical order so that sequential learners can proceed steadily though material. Arrange so that Holist leaner skip over detail and jump into a summary, Provide a concise-summary.
	Divergent thinking ↕ **Convergent thinking**	Guildford showed that divergent thinking type tends to produce a lot of idea and think creatively. They produce multiple solutions, but not one right answer. Convergent thinking type tends to think rationally and theoretically and go toward right answer.	Kolb(1983) made 4 types of learning style of combination with consist of divergent, convergent and abstract, concrete. ●**Activist** (doing and feeling preferences, =concrete-active ●**Reflector** (watching and doing, = concrete-reflective) ●**Theorist** (watching and thinking, = abstract-reflective) ● **Pragmatist** (thinking and doing, = abstract-active) This is only tendency
	Abstract-information preference ↕ **Concrete-information preference**	The better abstract information preference tends to prefer, the higher information is abstract and they are good at promote thinking by deduction. Concrete-information preference tends to promote their thinking starting from concrete information by induction	

Learning style (continue of "2")	↕	When taking in information made by the language, there are two kinds of people who is good at taking in information by listening or who is good at taking in information by reading.	Audio –input media—a techaer, Narration is good. Visual-input media----a book, film, images, visual-material is effective.
		Image-information preference is good at operating image or spatial image. Verbal-information preference is good at operating information, that is proposition and logical aspects. Most of result of tests show that there is little relation between high spatial ability and high verbal logical ability.	Verbal one--- book and teacher Verbally logical information is good for them. Image------Film, picture, Diagram. Intuitive information is good for them.
		Right brain—patern cognition, holist,intuition, Imagination. Left brain –verbal, analysis, logical,categorization.	This is abstract and big criteria of distinguishing. This categorization sum up other all learning styles into two, corresponding the function of brain,
	Female ⇔ Male	This tendency of difference is based on right and left brain dominant.	
3 Properties of cognitive difference	**Field-dependent type** ↕ **Field-independent type**	Witkin(1953) showed that field-dependent type tends to see whole view of field, while it difficult for them to see elements which constitute whole view. Field-independent type is opposite. They tend to see elements. It is measured by EFT.	Learning styles had no effect on student achievement or attitudes in Web-dependent instruction or in traditional instruction.(Tina M. Day Matt R. RavenMichael E. Newman)
	Reflective ↕ **Impulsive**	Kagan(1963)showed that reflective type tends to take time to answer but give back an accurate answer. While impulsive type takes little time but give back inaccurate answer.	The time giving students to think is differ and the way to progress thinking.
	↕	Smith and Klein(1953) showed that flexible type tends not to care cognitive intervention. They are good at evading external intervention and respond the stimulus which they should respond to. Control type is prevented from responding the main stimulus by external interventions. Because they tend to be distract their attention from the main by external stimulus.This can be measured by Stroop Color World Test	Recent research prove this is caused by the individual difference of working memory capacity, WM inhibit and remove task-irrelevant information. So unrelated information should be eliminated for control Learners and divide information Visual and verbal.
	High capacity ⇔ Low apacity of WM	Low capacity of working memory people tends to feel difficult to read and write. While high capacity working memory people learn the word low frequency, read and write well.	

Who gets most effective result from multimedia presentation?

Figure;2

	Type of Diffrence	Why is it effective/or not effective for those learners?	Application
Effective result group	**Non-verbal preference**	NVs can use multimedia presentation more effectively. Because they can interpret text into mental picture, so they can quickly judge whether presented-graphics is informable enough to prove the problem. NV need not support system when processing graphic information but they use more support when their processing verbal and calculation.	When dealing with math, they tend to refer to a formula but their interests disappear when added the verbal interpretation. So present formulas, just as it is for them. And less help of graphic and more help of text should be presented close to the text where they are troubled with.
	High Spatial ability learner	High-spatial learners have the cognitive capacity to mentally integrate visual and verbal representation from effective multimedia presentation. Spatial ability is generally defined as the ability to generate, maintain, and manipulate mental visual image(Carroll,1993)	Vicentet an Williges(1988) found that spatial ability affected the user's ability to navigate a large file structure. So for them, the presentation using configuration would better.(i.e)hierachey)
	Low knowledge Learner	Low-knowledge learners are less able to engage in useful cognitive processing in the lack of the presentation guidance.	For them, the reference supports to compensate their knowledge is effective.
	Boys	Benefit better from non-interactive and low-intrusive(forced) hints	Boy would prefer self-oriented discovery at own pace.
	Low WM	Low-working memory people feel difficult to Retrieve and maintain information.	So for them, the aid to hold information is effective.
So-so result group	**Verbal Preference**	When reading graph, Verbal type have to reference added text explaining the graph so they take more time to read graphics.	When presenting symbolic information, hints are effective for them.
	Low Spatial ability	Low-spatial people have difficulty in holding visual image long enough to process mentally integrated representation.	For them, hint and reference to support their memory retention is effective in text and graph.
	High knowledge Learner	High-knowledge learners don't be influenced by the design because they can compensate for lack of guidance in the presentation with their prior knowledge.	They are afford to process new information, so the more detailed contents should be provide for them, as long as they wish to know
	Girls	Benefit better from highly interactive hints. And show lower interest in mathematics.	Girls would have good effects from animated personal agent.
		They have high reading comprehension and Process diverse meaning when they read And write sentence.	