Research on Impacts of the Learning Motivation on the Modality Effects in Multimedia Design

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Abstract. The modality effect is one of the cognitive load theory effects. It mainly introduces that the images and texts would be presented to learners at the same time when designing multimedia and compared with learning the text information by visual modality, learning by auditory modality is more helpful. The related researches in the past only proved the objective correctness of this effect from different aspects. However, few people had discussed the relationship between motivation and this effect, that is whether the motivation would impact on the modality effect or not and what the impact should be. This research explored those mentioned issues by the empirical method, and the conclusion is as following: learning motivation has indeed influence on the modality effect; learning content in courseware can stimulate the motivation of learners; the results of dual modality and motivation are significantly higher than single modality.

Introduction

The progress of science and technology makes the educational technologies constantly update. These technologies are applied more and more widely in education field. However, with the development of educational technology, people have realized that simply applying the advanced technologies cannot achieve the ideal effects about the promotion of learning. So, scholars give the science which comes being recent years more attention. It can better realize the value of the technology and the teaching effect better when people deeply understand and abide by learning cognitive rules and apply to appropriate technologies. There was no evidence can prove it is effective to ignore the instruction of human cognitive structure but only use technology. Therefore, many researchers on educational technology begin to divert their focus from technology to cognition and develop the technologies based on the characteristics of human cognitive structure. And it is necessary for researching the cognitive load when studying the human cognitive process, but it is inevitable to involve in the motivation factors when researching the cognitive load. Although academia has not yet reached an agreement about whether the motivation should be included in the cognitive load theory or not, the production of this disagreement has shown the motivation would impact on the cognition of human beings. Are there any impacts of the motivation on the modality effect in cognitive load theory? If there are, and what is the degree of those impacts? In this thesis, the mentioned issues will be explored by importing the motivation variables into modality effect experiment.

Presentation

With the rapidly development of the information technology, multimedia learning has become the main way of learners learning. Generally, the multimedia courseware of each disciplines is compiled by the teacher. Then how to design a good courseware and achieve a good effect? That it becomes a key point for the teachers and researchers, while modality effect is one of principle which people must consider when they design the multimedia. This effect shows that the multimedia which consists of image and interpretation has the better impact than the multimedia which consists of images and text. In other words, compared with text representation, Sound representation can make students learn better when people show the multimedia information. [1] This is an important conclusion of cognitive load theory. Mr. Mousavi, S.Y., Low, R. has proved
the modality effect is a form of separation concentration effects when he researches the separation concentration effect. This thesis takes the courseware design of middle school geometry as an example, bases on the studies of predecessors about the cognitive structure of modality effect and combines with the motivation factors to make further discussion. The motivation can improve the learning efficiency, this idea has been proved through a lot of researches, so a hypothesis could be made that the motivation is able to impact on the modality effect and below to verify it.

The Analyses of Learning Motivation and Modality Effect

The Relationship between Learning Motivation and Learning

The motivation in psychology is often defined as "the dynamic or power which can drive people activity and includes personal intentions, desire and psychological impulse or attempt to achieve the goal " Based on this definition, the learning motivation can be defined as "an inner process or internal psychological state is to stimulate the individual learning activities, maintain the learning activities which have been aroused, and lead to behavior toward a certain learning objectives." According to different standards, the motivation has different classification, such as biological motivation and social motivation, internal motivation and external motivation, conscious motivation and unconscious motivation, distant motivation and proximal motivation, dominant motivation and auxiliary motivation. In addition, Ausubel divided the learning motivation into cognitive drive, ego-enhancement drive and affiliated drive. The cognitive drive is a need to demand people to know and understand the surroundings, to master the knowledge, and to expound and solve the problem systematically. In learning activities, cognitive drive refers to learning task (to acquire knowledge), it is an important and stable motivation. Because it is provided by learning to meet the demand (acquire the knowledge), therefore it is also defined as the internal motivation. Ego-enhancement drives refer to individuals by their academic performance and obtain corresponding status and prestige. It does not directly point to knowledge and learning task, but regard the academic achievement as a source which can obtain the status and self-esteem. Affiliated drive refers to get praise or recognition from elders (such as teachers, parents) or collective, they show a need to do work well. This motivation characteristic is prominent in young children' learning activities, it characterized by the pursuit of the good grades and the purpose is to win the praise and recognition. This research will be based on these three drives to stimulate the motivation of learners in the experimental process. And this temporary motivation before learning is mainly the proximal and dominant.

Learning motivation has the following three functions about learning: the first function is to promote learning. American psychological Atkinson summarize the motivation literature and get a common conclusion: the time of engaging in a specific learning task and the motivation levels of finishing the task are positively correlated. The Second function is to guide the learning. Learning motivation is not only to promote the learning action but also to make the learning action have a solid and complete content, and to come close to a certain goal. The Third function is to effect learning by the motivation strength. A lot of researches have shown that too strong or too weak learning motivation have a bad influence on learning, only proper learning motivation is beneficial to learning. In turn, of course, the learning effect will impact on learning motivation. Ausubel had explicitly pointed out: “the relationship between motivation and learning is a typical complementary, not one-way relationship.” Therefore excellent grades will make students have a positive learning experience and further strengthen the learning motivation.

The Explanations of the Cognitive Load Theory in Multimedia Learning to the Modality Effect

The study of modality effect generally includes three modalities. And multimedia learning is mainly involved in the two modalities about audio and visual which are discussed in this thesis. On the basis of two modalities about audio and visual, multimedia learning can be divided into five steps:
First, to select the related words from the present text or interpretation. Second, to select the relevant images from pictures. Third, to organize the selected words for coherent verbal representation. Fourth, to organize the selected images for coherent vision representation. Fifth, to integrate the visual representation and verbal representation characterized with previous knowledge. From these five steps it can be concluded that it includes multiple information sources when students learn the multimedia, and every information source in the isolated state is difficult to be understood. So only by putting them together (Low and Sweller, 2005), avoiding producing effects of divided attention (one of the effect of cognitive load theory) and increasing the cognitive load, to better improve our learning efficiency.

Cognitive load theory was proposed by John wheeler (Sweller, J.) from the two phases of information processing: working memory and long-term memory. Cognitive load refers to increase amount of mental activity in working memory by one time when processing the information (Cooper 1998). It is divided into extraneous cognitive load, and intrinsic cognitive load and germane cognitive load. Extraneous cognitive load also known as invalid cognitive load, associated with the organization and presentation of learning materials, and caused by improper teaching design. Intrinsic cognitive load refers to the internal complexity of learning materials. Germane cognitive load is the mental effort and caused by schema construction and the automation. The modality effect refers to impact on working memory load through declining or increasing the extraneous cognitive load under the same condition of the intrinsic cognitive. Working memory is made up of many modalities or processors (Baddeley, 1992), and the auditory processor and visual processor are independent. In some cases, if people use the two processors at the same time, it can expand the effective capacity of working memory. This can explain the issue why the dual modality learning could produce higher efficiency than the single modality. So there are based on the modality effect to propose the multimedia learning theories as follows: First, learners process the information through two modalities. The auditory modality process the information which people can hear. The visual modality process the information which people can see. Second, the capacity of two modalities is limited. Third, there is actively to process the information when learners are learning. So we should follow the theory foundation when we design the multimedia. Only following the theory we can make multimedia courseware more appropriate to the learners' cognitive structure characteristics and more beneficial to the learning of learners.

The Experiment: The Influence of the Learning Motivation to the Modality Effect

Preparation

In order to research the learning motivation to impact on the modality effect in the multimedia design, and try to ensure the experiment be scientific. This research testes the motivation effect experiment in the second year of 45 classmates from Hebei province.

The Experimental Grouping Scheme. Selecting the classmates as the experimental samples is to ensure that students are in the same background and learning atmosphere. And the group needs to have homogeneity. The level should be equal between the whole group and every single group. To achieve this goal, this experiment selects 45 students and they are divided into three groups, each group have 15 students. Grouping scheme is as follows: the first step, according to the rankings, we divide 45 students into three groups which include A 1 - 15, B 16-30, C 31-45, (we view top 15 as the same learning levels, the middle 15 as the same level, the last 15 as the same level, assuming there is almost no different at the same level students). The second step, we randomly pick a student into group D from group A, B, C, and randomly pick a student into group D from the remaining of group A, B, C, until the group D have 15 students (so we need pick five times), according to this method to select 15 students into group E, F. So it can ensure these students from group D, E, F at the same level. The grouping scheme is based on above assumptions, ruled out the irrelevant factors, and remained a variable of the motivation. Then group D use graphics and multimedia of text to learn, group E use graphics and multimedia of explanation to learn, group F use graphics + multimedia of text to learn and stimulate the learning motivation, that is to join the motivational
variables, finally testing the learning result of each group students, in order to observe the whether
the learning motivation has influence on the modality effect or not.

The Identification of the Experimental Subject. In order to achieve the purpose of this test and
try to avoid the occurrence of ceiling and floor effects. It is the best for the testers to design the
difficult questions about above average. So the author and the discipline teachers take the
consideration carefully about how to select the questions. According to the progress of courses, the
understanding of teachers to the condition of students and teaching experience from many years.
Finally, the geometric proof referring to Triangle median line theorem is defined as test subjects,
because the content is the new content for students, so that we can guarantee the challenge of the
subjects. At the same time this theorem is very easy to learn, students can quickly prove some topics
to use this theorem .And then the subjects are made to be the form of multimedia for learning of
students, such as above description.

The Experimental Process

Students from this three groups (D,E,F) enter the computer room in batches and use their
multimedia courseware to learn, that is group D: graphics + text, group E : graphics + explanation,
group F: motivation + graphics + text. Students need to learn about the content of the triangle
median line theorem before they study geometry proofs, students begin to learn the next test
subjects when they had learn the previous content, the test subjects as follows: as shown in the
figure, in $\triangle ABC$, D is the midpoint of AB, E is the point of trisection of AC, $AE = 2EC$. BE and CD
meet in point O. Verify $OE = \frac{1}{4} BE$.

![Figure 1. Test subjects about content of the triangle median line.](image)

The limited time of learning is based on the learning time of the dual modality learning of group
E, which is at the end of the explanation, the explanation time last 2 minutes and 34 seconds.
Moreover, Group F need to stimulate the learning motivation of students, through researching the
way of stimulating the learning motivation of the students from the past. This experiment stimulate
the motivation of students from these following aspects: render the interest learning of the subject,
focus on the purpose of the learning, and stimulate the self-efficacy of students.

After all of students from these three groups finished the learning program, based on the theory
of the motivation classification from Ausubel, through the form of questionnaire, adopted the Likert
4 point measuring method, measured the learning motivation level for each groups to verify the
motive stimulating effect of group F, and then enter the test phase of learning effect. According to
the junior middle school students complete the text paper to use how much time, the test duration
last 5 minutes.

The Experimental Result

Verify the motive stimulating effect of group F, such as Table 1:
Table 1. The variance analysis about the learning motivation level of three groups.

<table>
<thead>
<tr>
<th>(I) Groups</th>
<th>(J) Groups</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group D</td>
<td>Group E</td>
<td>-.50000</td>
<td>.79376</td>
<td>.805</td>
</tr>
<tr>
<td>Group E</td>
<td>Group F</td>
<td>-3.00000(*)</td>
<td>.79376</td>
<td>.002</td>
</tr>
<tr>
<td>Group F</td>
<td>Group D</td>
<td>.50000</td>
<td>.79376</td>
<td>.805</td>
</tr>
<tr>
<td>Group F</td>
<td>Group E</td>
<td>-2.50000(*)</td>
<td>.79376</td>
<td>.009</td>
</tr>
<tr>
<td>Group E</td>
<td>Group F</td>
<td>3.00000(*)</td>
<td>.79376</td>
<td>.002</td>
</tr>
<tr>
<td>Group D</td>
<td>Group E</td>
<td>2.50000(*)</td>
<td>.79376</td>
<td>.009</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the .05 level.

The results of Variance analysis show that the motivation level of group F is significantly higher than the other two groups (F = 8.200, p = 8.200), and it suggests that it is effective to stimulate the motivation.

Verify the result of three groups, such as Table 2:

Table 2. The variance analysis about the result of three groups.

<table>
<thead>
<tr>
<th>(I) Groups</th>
<th>(J) Groups</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group D</td>
<td>Group E</td>
<td>-2.46667(*)</td>
<td>.67769</td>
<td>.002</td>
</tr>
<tr>
<td>Group F</td>
<td>Group D</td>
<td>1.73333(*)</td>
<td>.67769</td>
<td>.037</td>
</tr>
<tr>
<td>Group E</td>
<td>Group F</td>
<td>-1.73333(*)</td>
<td>.67769</td>
<td>.002</td>
</tr>
<tr>
<td>Group F</td>
<td>Group E</td>
<td>.73333</td>
<td>.67769</td>
<td>.530</td>
</tr>
<tr>
<td>Group D</td>
<td>Group F</td>
<td>-1.73333(*)</td>
<td>.67769</td>
<td>.037</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the .05 level.

Table 3. The descriptive statistics about the result of three groups.

<table>
<thead>
<tr>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>7.0000</td>
<td>1.81265</td>
<td>.46803</td>
</tr>
<tr>
<td>15</td>
<td>9.4667</td>
<td>1.95911</td>
<td>.50584</td>
</tr>
<tr>
<td>15</td>
<td>8.7333</td>
<td>1.79151</td>
<td>.46257</td>
</tr>
<tr>
<td>45</td>
<td>8.4000</td>
<td>2.09328</td>
<td>.31205</td>
</tr>
</tbody>
</table>

The results of variance analysis and descriptive statistics show that the score of group E (the dual modality) is significantly higher than group D (the single modality). This confirmed the objective existence of the modality effect. The score of group F (the motivation + the single modality) is more different and higher than the group D, and there is no significant difference with group E. This suggests that the motivation has influence on the modality effect. But according to the descriptive statistics, it can be known that the result of D and F is the dual modality group (E) is difficult to be overtaken, and only could be approached.

The Discussion

The experimental results verify the experimental hypothesis at the beginning. The motivation impacts on modality effect at some extent. Why modality effect would produce, and how the motivation impact on modality effect, which can be explained by the cognitive load theory: As to the single visual modality, the eyes must constantly wandering between graphics and text in the learning process. It distracts their attention and increases the visual modality load to this group of students. The dual modality refers to focus on geometry and listen to the process of proof carefully. The visual processor and auditory processor operate at the same time to increase the effective capacity of working memory. So the learning efficiency of dual modality is higher than the learning efficiency of single modality. This is the reason about producing the modality effect. It can
influence the modality effect to stimulate students' learning motivation. This is mainly due to the
influence of cognitive load at work. Generally, stimulating students' learning motivation is beneficial
to increase the correlation cognitive load. And this cognitive load can improve learning. The
research shows that there are three kinds of cognitive load at work when we use multimedia for
learning. These three cognitive loads are reciprocal relationships. Because the capacity of working
memory is limited. So the amount of these three kinds of cognitive loads will be limited within a
certain range. According to the interpretation about these three kinds of the cognitive load concepts
in this text, we should control the intrinsic cognitive load, reduce extraneous cognitive load and
increase the correlation cognitive load to improve the learning efficiency. In the case of the learning
materials do not change. That is, under the condition of the intrinsic cognitive load does not change,
stimulating the learning motivation can increase the correlation cognitive load and reduce the
external cognitive load, and improve the learning efficiency. In fact, stimulating the motivation can
pay limited attention to the learning content and reduce the extra expending. Meanwhile it makes
students want to pay more cognitive effort for learning, to enhance cognitive motivation, to speed
up the operation rate of working memory, and to reduce the cognitive load level.

However the motivation effect does not make the group F of motivation + single modality
emulate or exceed the group E of dual modality. It shows that the motivation can impact on it. But
the modality effect is the main effect. To some extent the motivation can only make up the shortage
of the learning of single modality, not completely replace the advantage of dual modality. It means
that it is limited to increase the correlation cognitive load or reduce extraneous cognitive load by the
motivation.

Conclusions and Implications

Through the research results and the support of relevant cognitive load theory, people can get the
following conclusion and revelation: 1. learning motivation has indeed influence on the modality
effect. And this effect is unable to change the modality effect but compensate. Therefore, People
should follow the modality principle of cognitive load when we make multimedia design. 2. Due to
restricted by objective conditions or other reasons, people show learning content only through the
single modality form when they are designing multimedia courseware. So that people can properly
fill learning content in courseware which can stimulate the motivation of learners. For example:
Improving the interest of learners and challenge and significance of learning contents through
presenting learning materials by different form. Making learning content close to real life and
feedback or rewarding the learners' learning results. 3. The Results of dual modality and motivation
are significantly higher than single modality, and there is no significant difference between them.
Stimulating the motivation and dual modality teaching play a stimulative role in learning, and their
impacts are similar. So only paying attention to the external technical factors and ignoring inner
psychological factors of students in the process of our teaching, or conversely, are not desirable.
People should value internal, external, subjective and objective factors.

The Limitation

Due to the limitation of research conditions that the test samples are so less, it may produce some
error. In addition, how the learning motivation to influence the modality effect, it needs further
study by psychology, neuroscience, brain science. People hope to find the relationship between
motivation and cognitive structure. If the relationship had been found, the academic debates for
many years about whether motivation variables could be included in the cognitive load theory will
come to an end of a stage.

References

2006. (In Chinese Version)


