

Consciousness of “evolution” and “human gene” in German high school students

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An association map of “evolution” (Vererbung) indicates two meanings, ‘money’ and ‘gene’, among high school students in the Rhein district in Germany. What the students know about “evolution” includes biological words, social development and alteration of planets in transferred meaning.

High school students in Germany know more about “human gene” than Japanese students at Nagasaki University. What high school students know about “human gene” seems to depend on the media. Over 20% among the testees in Germany remembered critical words or words to reconsider about “human gene”.

As a background of ethical consciousness, an association map of “Ethik” is shown. “Ethik” is combined with religion in Germany. On the other hand Japanese university students in Nagasaki remember names of European thinkers from the stimulus word.

I Introduction

Genetic surveys occur world wide, especially competitively in developed countries. After the reading of the human genes in 2003, the potential of gene techniques and the meaning for humanity has been discussed more. Discussions for acceptance and rejection of what gene research can bring should also be compared and examined.

The aim of this survey is to investigate the consciousness about the human genes in Germany, where the control of genetic research is stricter than in the U.S.A. and Japan. The quantity and quality of discussion about genetic research in Germany seems large and high, in contrast with Japan.

There may be a difference in knowledge and a difference of consciousness between Germany and Japan. There may be a more critical consciousness in Germany about Evolution and genetic research than in Japan, when a policy of a country depends on the consciousness of people. The consciousness of people towards gene is based on peoples’ experience, religious and moral discussion, and peoples’ education. These historical, inter personal and character building factors reflect politics in a democratic country, and politics can lead to peoples’ judgments.

II Method

An association test is a good method to gather information about the whole consciousness of a word at once including knowledge and feelings. The whole consciousness is expressed as an association map. Each testee answers from a given stimulus word as many words as they can remember in 30 seconds. Testees responses are formed as an association map to show what they think in total.

Association tests about the consciousness of "evolution" and "human gene" were conducted on the 9th, 10th and 11th grade in July 2003 on high school students in a gymnasium of Nordrhein-Westfalen and a Hauptschule in Rheinland-Pfalz Germany. The number of testees as a whole was 60 in 7 classes, two thirds were students of the Gymnasium, and the number of males and females was almost equal. The number of every grade was also almost equal. The time for free association on the test was 30 seconds for each stimulus word. Student's responses were written on test papers by themselves.

A survey of Japanese students at Nagasaki University mainly at the faculty of Education is used to compare with the consciousness of high school students in Germany. The survey of German students in Osnabrueck and Leipzig, mainly studying Education, is also partly used for the comparison.

A high school teacher in Germany has asked me if the result of the association test of the high school compared with the consciousness of university students. The teacher wanted to say it's unfair to compare with the university students because the lower grade high school students do not learn biology yet.

But consciousness depends not only on learning in class but also on information in background life and mass media. The word "evolution" is used in transferred meaning as social evolution, and as even the evolution of planets, as will be seen in the association map later (Figure 2). Information about human genes is often discussed in a social dimension, which builds up what people know about it, and by which judgment and feeling can be guided. Naturally it is better if what people know is supported by appropriate knowledge of biology.

Consciousness can be compared between high school and university, especially between high school students of Germany and Japanese university students.

III Association map

The image of the word "inheritance" by Germany high school students is shown for the first to clarify the consciousness of "human gene", which prescribe the human heredity.

III-1 Inheritance

The word "Vererbung" has two meanings like inheritance: 1) money or property received from someone who has died, and 2) particular genetic characteristics or qualities from parents or ancestor, which one was born with. The Japanese word "iden" has only the genetic meaning.

This double meaning is clear in Figure 1 when 40.0% of high school students thought of 'money' based on the stimulus word and 33.3% 'gene'. University students in Germany associate both sides of the stimulus word, but mainly in the direction of 'gene', 46.1% of the students, or 'Genetik', 24.7%. Japanese university students associate 'DNA' (32.6% of the students), 'parent' (29.2%), 'parent and child' (28.1%), and 'gene' (24.7%).

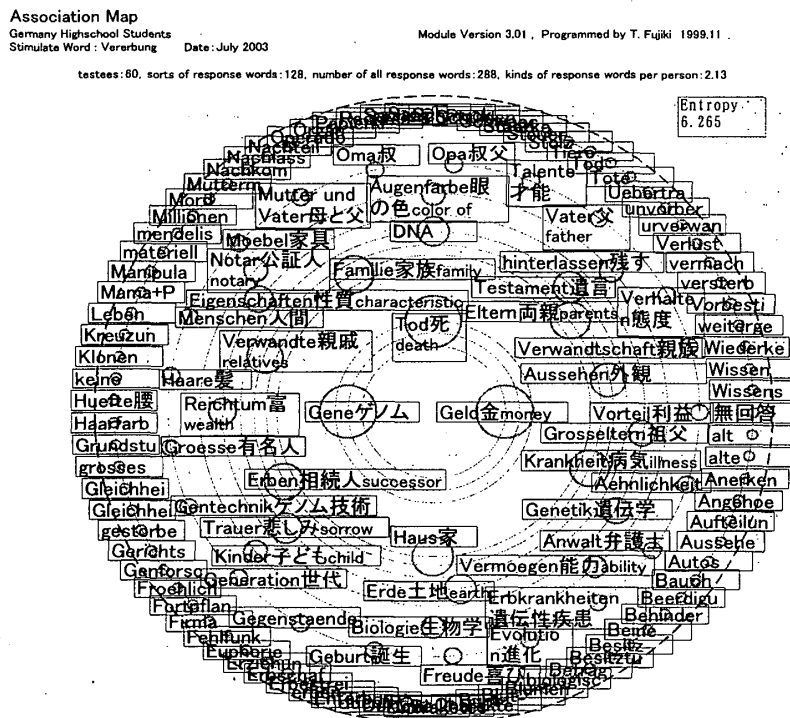


Figure 1

The double association increases the kinds of response words per person: in high school students in Germany the kinds of response words per person is 2.13 (words). For students in German universities, 2.11, but the number for Japanese university students is 1.67. Entropy, the degree of scattered words, is for high school students in Germany 6.265 (bit), for university students in Germany 6.608 and for university students in Japan 6.235.

These differences of association in high school students and university students in Germany seems to depend on learning. 'Gene' (46.1%), 'Genetik' (24.7%), 'Krankheiten (illness)' (24.7%), 'Biologie' (18.0%), 'Eltern (parents)' (16.9%),

'Eigenschaften (characteristics)' (15.7%), 'Mendel' (14.6%) and 'Chromosomen' (12.4%) are directed to the area gene after learning and information, except 'Eltern (parents)', which can be interpreted in both directions. The word 'Geld (money)' (40.0% pro testee), which was the top of the response words in high school students, is in university students only 3.3% in Germany, and 'Tod (death)' (28.3%), which is a third of response words in high school students, is in university students 4.5%.

There is no response like 'money' or 'death' in Japanese university students, because of the lack of such an idea to receive property in case of death in the stimulate word. Also, the low numbers of the kinds of response words per person and entropy in Japanese university students can be interpreted as the lack of inheriting property.

But this tendency can be interpreted as showing that the concentration of Japanese university students can be lower than that of students in Germany. Not only for the word "Evolution" but also for the stimulate word "mountain" and "white", which do not have double meanings, and in which both marks are low in Japanese students.

Table 1 Comparison between three Researches

Vererbung 遺伝 inheritance	entropy	kinds of words per person
High School students in Germany	6.27	2.13
University students in Germany	6.61	2.11
University students in Japan	6.24	1.67
Berg 山 mountain	entropy	kinds of words per person
High School students in Germany	6.10	2.00
University students in Germany	6.85	2.62
University students in Japan	5.97	1.88
weiss 白 white	entropy	kinds of words per person
High School students in Germany	6.10	2.00
University students in Germany	6.61	2.39
University students in Japan	6.39	2.04
Evolution 進化 evolution	entropy	kinds of words per person
High School students in Germany	5.75	1.75
University students in Germany	6.37	2.19
University students in Japan	6.31	1.72

Looking at the details of numbers of the kinds of response words per person and entropy in the case of the word "Evolution", the number of the kinds of response words per person in high school students in Germany (1.75) is almost the same as that of the students of Nagasaki (1.72). The kinds of response words in Table 1 is always low in Japanese students. But the entropy of Japanese students (6.31) in the case of "Evolution" is almost the same as that of university students of in Germany (6.37). This difference can be interpreted as a result of learning. After learning "Evolution" the kinds of words increased, so that the entropy became higher in Japanese students. The entropy of a word which needs knowledge can increase with learning. This tendency also happened in the case of the word "Vererbung", but because of the double meaning of the word the entropy in Japanese students did not increase to the level of university students.

III-2 Evolution

The association map of “Evolution” is divided into four categories (Figure 2). The category [know] includes not only knowledge but also something the high school students in Germany know about “Evolution”.

In the category [know] four dimensions appear: in the biological dimension there are words like ‘Tiere (animals)’, ‘Affen (monkey)’ and ‘Dinosaurier’, in the dimension of social history there are words like ‘Geschichte (history)’ and ‘Steinzeit (Stone Age)’, in a more transferred use ‘Urknall (Big Bang)’ and the words for the definition of evolution like ‘Entwicklung (development)’, ‘Veränderung (change)’, ‘Fortschritt (progress)’, ‘Verbesserung (improvement)’ and ‘Darwin’. The response word ‘Menschen (human)’ may come out in plural dimension.

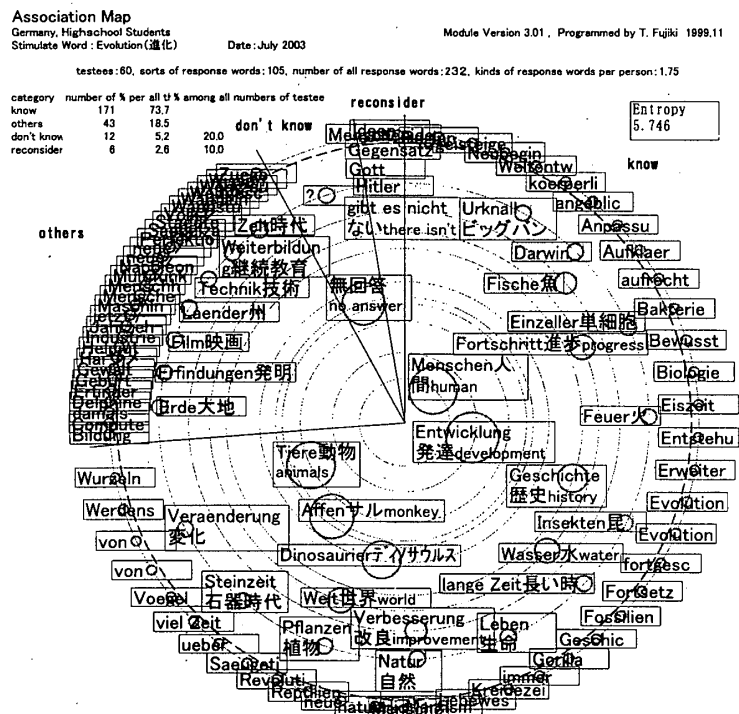


Figure 2

The lower grade of testees haven't yet learnt “Evolution”. So that 5.2% of all the words are ‘no answer’ or ‘?’. The number of ‘no answer’ ([don't know])12, as seen on the left of Figure 2, is 20.0% for all testees.

There also appear words which show negative reactions or the stand point for reconsidering evolution theory. The words ‘gibt es nicht (there isn't)’, ‘Gott (God)’, ‘Hitler’ and so on come out in a category [reconsider].

Negative or reconsidering consciousness is 10.0% of all the number of testees. The same consciousness in university students in Germany is 22.5%, and that of the students in Nagasaki is 9.0%. There is a difference of consciousness about the category [reconsider] between the university students in Germany and in Nagasaki ($p < 0.05$).

III-3 Human gene

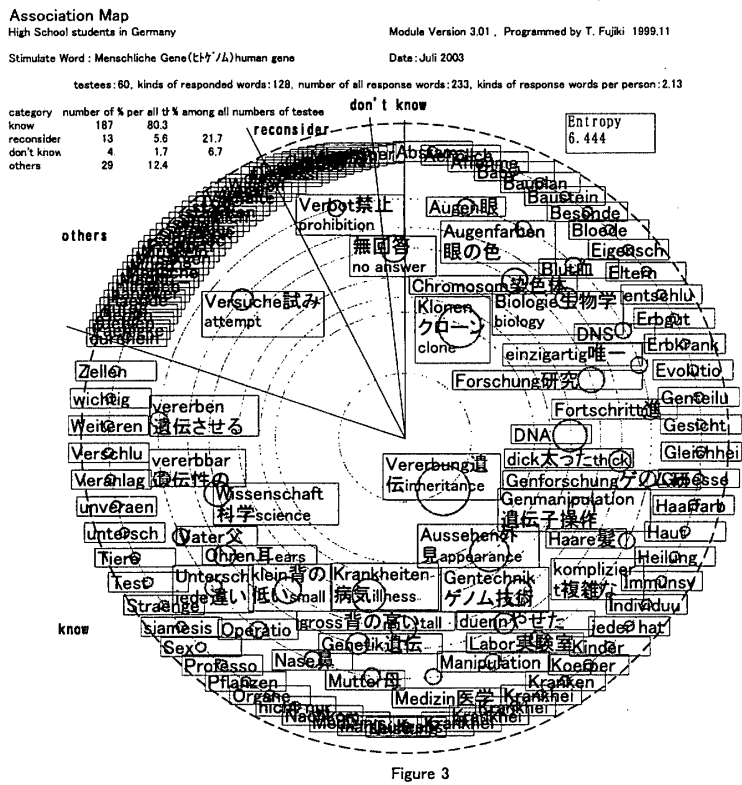


Table 2

Menschliche Gene (ヒトゲノム) human gene	entropy	kinds of words per person	category: don't know percentage of testee	category: reconsider percentage of testee
	bit	words	%	%
High School students in Germany	6.44	2.13	6.7	21.7
University students in Germany	7.08	2.49	2.2	24.7
University students in Japan	6.52	1.92	38.4	34.2

Looking at the categories of the map of [human gene] (Figure 3), those who don't know about human genes (6.7%) is not high in German high school students, though not all of them have learned biology in school.

Table 2 shows the difference of stimulus word "Menschliche Gene" between the students. The difference of [don't know], of kinds of words and entropy and of words between two countries looks to indicate differences in social and school situations.

The number of category [don't know] of human genes in students of Nagasaki University (38.4%) is larger than others ($p < 0.01$). Japanese students know not so much about human genes in contrast to German students. German high school students know more than Japanese university students ([don't know] 6.7%).

The kinds of words of a high school student in Germany is not low, and the entropy is not so small compared with Japanese students. There are more various words about human genes in high school students in comparison with Japanese students.

'Vererbung (inheritance)' (40.0% per testees and 'Klon (clone)' (16.7%) are the response words that many students answered. 5% of high school students answered 'Biologie (biology)'. The university students in Germany answered 'Vererbung

(inheritance)' (40.5% per testee) for the first, 'Chromosom' (18.0%) and 'DNA' (16.9%) follows. 'Biologie (biology)' is 11.2%. The association in high school students is bound by mediagenic themata like 'Klon (clone)', and their association is not bound with 'Biologie' in comparison with the university students in Germany. University students in Germany have studied 'Biologie' and know technical words like 'Chromosom' and 'DNA'.

In Japanese students the response words are mixed with three origins: mass media, learning and ignorance. In Japanese students 'Idenshi (gene)' is 21.9% (in Japanese "human gene" and 'gene' are two different words), 'kagaku (science)' 20.1%, 'kenkyu (research)' 11.0%, and 'clone' 9.6%, while 'DNA' 12.3%, and 'wakaranai (don't know)' 12.3%.

This indicates that the high school students in Germany know about human genes through mass media and in their life, while the university students in Germany learned about it. This suggests there is a lot of information about human genes which German high school students receive, while Japanese students do not learn so much from the media or in schools. Japanese students may be wondering about the meaning of gene research and application. A high percentage of the category [reconsider] can be changed in Japan, because the information seems lacking.

IV Back ground

I would like to discuss the backgrounds of the difference of consciousness in two countries in school education through an association map of "Ethik" and how evolution and human genes are taught in schools.

IV-1 Ethik

The difference of "Ethik (ethics)" in Germany and Japan is its relations with 'religion'. 'Religion' (53.3% among all testees) comes at the top of association among high school students in Germany, but the same word among university students in Nagasaki is 4.1%. Germany high school students think of not only 'Religion' but also 'Glauben (belief)' (15.0% in all testees) and Gott (god)' (10.0%). As a category [Religion] these two groups are different ($P < 0.01$): in German high school students this category is 33.0% of all the response words, and that of Japanese students 2.3%.

"Ethik" is in Japan a 'shakai (social studies) subject' (28.8%), which is taught in high school. The category [subject] in Nagasaki is 18.3% of all the response words. This percentage is the second high of the categories in Japanese students, which is different from that of high school students in Germany 9.9% ($p < 0.05$).

When "Ethik" is a subject in high school and has no relation to religion in Japan, the meaning of "Ethik" tends more to be [knowledge] (20.0% in all the response words)

such as 'Socrates' (16.4% of testees) and 'philosophie' (11.0%). The category [knowledge] in German high school students is 11.0% of the words, different to that of Japan ($p < 0.05$).

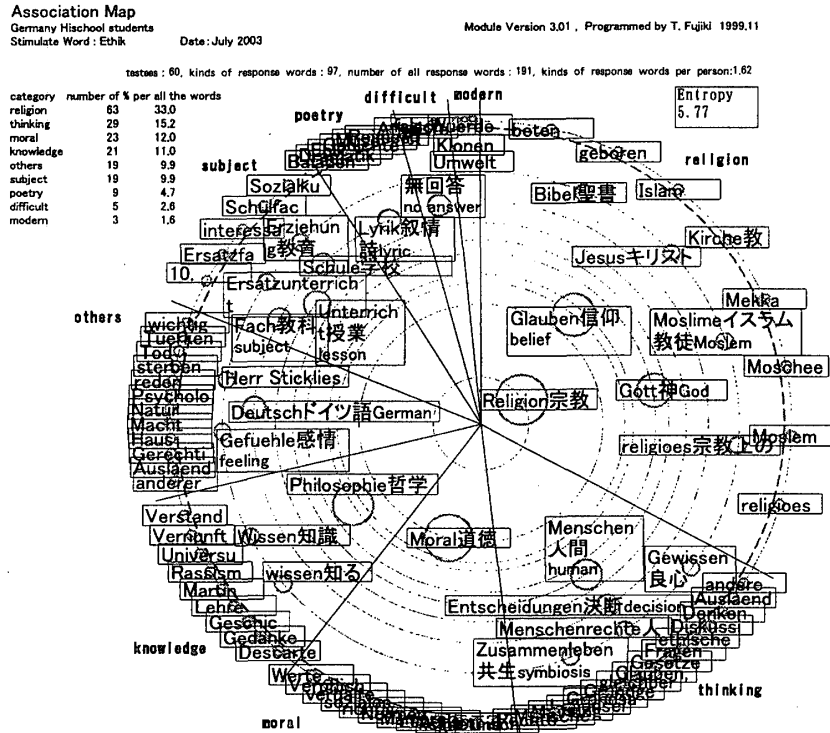


Figure 4

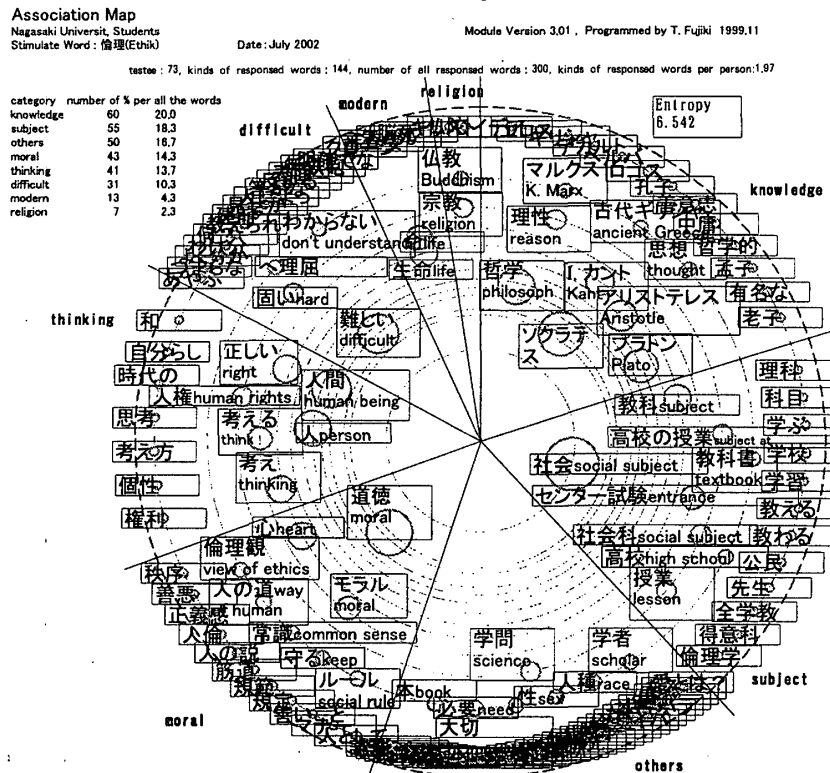


Figure 5

In Japan moral education in elementary school and junior high school and ethics in high school are prohibited to be combined with religion after World War II. In Germany ethics is a compensational subject for religion especially in former west German states, where this survey was conducted.

The word 'moral' is common in high school students in Germany (20% of testees) and Japanese university students (17.9%). Also as a category [moral] is not different in high school students (12.0% of all words) and university students of Nagasaki (14.3%). In both cultures there are two related words ethics and moral, and the associative distance of the word 'moral' from the word "Ethik" is almost the same.

IV-2 School textbooks in Germany

For human genes what should be learned and how it should be learned in school is a theme now and for the future in the age of decipherment of the gene code. This has the potential to change the image of human beings. In the background of the difference of consciousness between Japan and Germany there are differences of school textbooks. As a background of the consciousness of evolution and gene in Germany, there are progressive and detailed descriptions of school textbooks in Germany.

To prepare for the Abitur (entrance examination to university), there are books for example with titles 'Evolution, Abitur-Wissen Biologie'³⁾ and 'Zellbiologie, Grundlagenwissen und Übungsaufgaben, Duden Abiturhilfe' for 12th • 13th grade⁴⁾.

'Linder Biologie', a school textbook used in Gymnasiums commonly shows pictures of Watson and Crick, a gene transferred mouse and the method of somatic gene therapy⁵⁾.

Examination of amniotic fluid is written about in many school textbooks with a figure: for example 1) Fruchtwasseruntersuchung als eine Methode vorgeburtlicher Untersuchung (examination of amniotic fluid as a method of before birth diagnosis) Biologie heute 2R Eine Lehr- und Arbeitsbuch fuer das 7.-10. Schuljahr⁶⁾, 2) Amniozenteste, Biologie heute S II Ein Lehr- und Arbeitsbuch⁷⁾, 3) Entwicklungsbiologie, Materialien fuer den Sekundar-bereich II, Biologie⁸⁾.

Not only biological information but also the risks and ethical problems are discussed in a school textbook of biology, for example 'Risiken und ethisches Fragen der Gentechnik'⁹⁾ and 'Meinungen zum Klonen von Menschen', 'Ethische Aspekte der Reproduktionsbiologie - Fallbeispiele'¹⁰⁾.

A school workbook on 'Ethik' for 11th grade explains and discusses 'Gentherapie' and 'Leihmutterschaft'¹¹⁾.

These combinations of biological facts and social use in school will help to combine the knowledge and consciousness about the theme of human genes and provides the discussions of the theme in our age.

The theme of gene research and practical application is world wide. The decision to

apply results of gene research depends on our consciousness of the cultural background and education about human genes. The consciousness of high school students in Germany indicates for Japanese education two directions: 1) a need for overlapped explanation in different subjects, and 2) the need for a practical description which can meet the daily consciousness and the way of life in each culture. These efforts to offer a basic ground of scientific and social theme will enrich the quality and quantity of information and discussion of this theme.

Notes

- 1) In an association map the words, which many testees responded come near to the center of big circles. The words at the edge, the most outside of the big circle, means one word associated by one person. In association map Distance of response word from a stimulated word, so that the distance from the center of a circle (D_i) is calculated in the following way: $D_i = -\log_2 P_{pi}$ (bit). P_{pi} means how many testee had written a certain word: number of a word / number of testee. Volume of association (A_i) is used as a growth of acicle of one word: $A_i = -P_{pi} \log_2 P_{pi}$ (bit). Entropy is calculated in following way: $H = -\sum P_{wi} \log_2 P_{wi}$ (bit). P_{wi} is the number of a word in all the response words: number of a word / number of all the words.
- 2) In this paper a stimulate word by a association test is written with “ ”, a response word is showed with ‘ ’, and the category of the response words is written like [know]
- 3) by Henning Kunze, Stark, 1999
- 4) by Dr. Roland Klinger, Dudenverlag, 2000
- 5) written by Horst Bayrthuber und Ulrich Kull with Ulrich Basler, Johannes Hopmann and Wolfgang Rudiger, Metzler, 1998 use until 2005
- 6) by Strauss • Dobers • Knippenberg • Beuck, Schroedel, 2001, p.338
- 7) by Wofgang Miram und Karl-Heinz Scharf, Schroedel, used until 2005, p.220
- 8) by Wilhelm Weber • Bernhard Sieve, 2002, Schroedel, p.59
- 9) Linder Biologie, Metzler, 1998 use until 2005, p. 363
- 10) Entwicklungsbiologie, Materialien fuer den Sekundarbereich II Biologie, Schroedel, 2002, pp.61-62
- 11) Ethik ein Arbeitsbuch für den Ethikunterricht im 11 Schuljahr, by Uwe Gerber, Reinhold Mokrosch and Heinz Schmidt, Diesterweg/Kösel, 1990

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