BIOLOGY TEACHER AND EXPERT OPINIONS ABOUT COMPUTER ASSISTED BIOLOGY INSTRUCTION MATERIALS: A SOFTWARE ENTITLED NUCLEIC ACIDS AND PROTEIN SYNTHESIS

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ABSTRACT

The aim of this study is to collect and evaluate opinions of CAI experts and biology teachers about a high school level Computer Assisted Biology Instruction Material presenting computer-made modelling and simulations. It is a case study. A material covering "Nucleic Acids and Protein Synthesis" topic was developed as the "case". The goal of the material is modelling relevant terms and phenomena. Having formed the material, then expert opinions were asked for technical and teacher opinions for educational assessment. Research data were collected via: An Assessment Scale for Experts, An Assessment Scale for Teachers and A Teacher Interview. Data on Assessment Scales were evaluated by determining percentage-frequencies and material proved adequate both in educational and structural point of view. Both qualifying and quantifying Teacher and Expert assessments about the software on "Nucleic Acids and Protein Synthesis" were positive.

Keywords: computer assissted biology instruction, protein synthesis, DNA, chromosome structure, biology animation, CAI, case study.

INTRODUCTION

Problem

Studies have revealed that students have misconceptions over some basic biology concepts like nucleotide, gene, chromosome, DNA, nucleus etc. (Kindfield Ann, 1991; Brown, 1990; Yıldız, 2001). Once formed, these misconceptions are persistent and adversely affect pupils' present and further learning (Yıldız 2001). They may stem from; instruction, students' preconceptions or their inability of ripening the topic on the first exposure (Konuk and Kılıç 1998). It seems difficult for pupils to comprehend a complex topic like Protein Synthesis while they still have misconceptions about preliminary terms and concepts.

The Purpose of the Study

The human being thinks by models. Modelling in instruction helps students to understand complex topics, increases perception, provide students opportunity to observe phenomena impossible to observe in reality. They provide abstract and persistent learning (Yıldız 2001).

Modelling and study multimedia including simulations when they present real scientific knowledge are reported to contribute learning. (Marx and Toth, 1981; Bishop *et al,* 1984; Künzel, 1987; Burns, 1995;Ayersman, 1996; Yip, 1998; Provenzo *et al,* 1999; Schunk, 2000; Yıldız, 2001).

In this study a Computer Assissted Biology Instruction (CABI) material is developed to visualize the basic concepts of the "Nucleic Acids & Protein Synthesis" unit. The material is suitable for high school biology curriculum (9^{th} and 11^{th} grade) and can be used to support traditional instruction. It is a multimedia presenting animations and vocal and written descriptions, prepared in Macromedia Flash. The scripts of the content are extracted from 9^{th} and 11^{th} grade biology textbooks and enriched with Wannamaker (2001) and Nova (2003) internet resources and 'Ona Kısaca DNA Denir' and 'Sen Ben Gen' Balkwill & Rolph (1998) books. Then the material is exhibited to the CAI experts and biology teachers and the answers for these questions are inquired:

1. Is the CABI material adequate in structural point of view?
2. Is the CABI material adequate in educational point of view?

MATERIAL & METHOD

Method

Case study is defined as to study a suitable case whose boundries are well defined in detail (Stake 1976). It is a method which can include all other research methods. It focuses reason and result relationships (Çepni 2001). In this study the case investigated in detail and without an efford to make generalization. It is a 'dominant – less dominant design' (Creswell 1994) which favours qualitative data so; whose epistemological roots are rather into interpretative paradigm. For this reason

ontological assumptions are onto nominalism.

The preparation of the material

The material is developed through the defined objectives for 'Nucleic Acids and Protein Synthesis' unit which is chosen for being suitable for modelling.

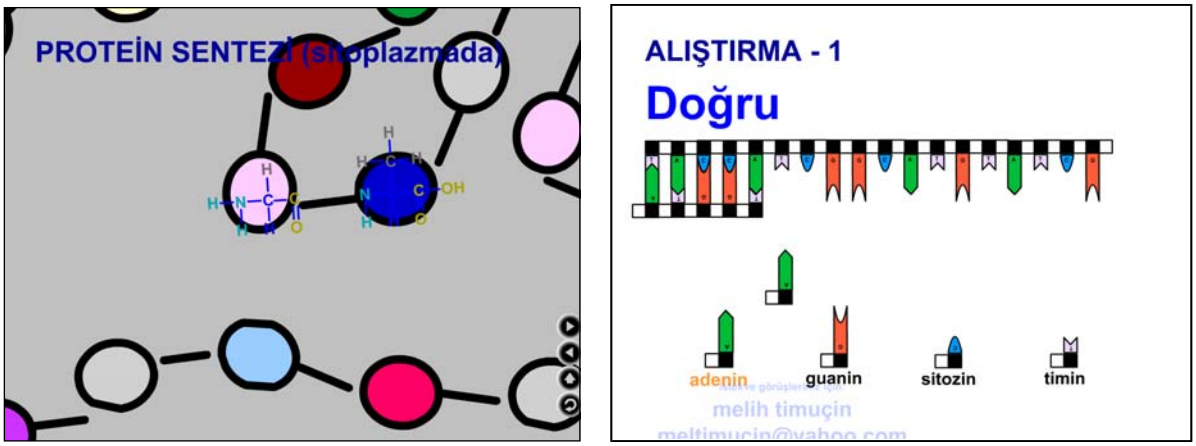

Figure 1 Screenshots from the material.

Data collecting tools

To determine the vices and virtues of the material **Teacher Interviews**, **Teacher Surveys** and **Expert Surveys** are used. Educational Appropriateness can be defined as the degree of the material to present instructional activities to make students attain the goals of the subject (Şahin 1999). Teacher Interviews, Teacher Surveys are prepared to assess educational appropriateness. Structural Appropriateness is the degree of the appropriateness of the structural properties of the material, such as; appearance, sound, screen order etc. Expert Surveys are prepared mainly with the aim of assessing structural appropriateness.

Sample

To assess the material 9 Computer Assisted Instruction (CAI) experts from Karadeniz Technical University (KTU) and Middle East Technical University (METU) and 16 biology teachers working in different schools in Trabzon are surveyed after using the material. The teachers are also interviewed simultaneously. Teachers are given a detailed Teacher's Guide for Teachers including objectives and instrucitons.

Expert survey

The survey is a 14-item likert scale. Data from the survey tabulated in terms of percentage and frequencies. The survey is extracted from the 39 item scale developed by Price (1991) by concerning four fields developed by Hannafin and Peck (1988). During this extraction especially items supporting instructional field are chosen. To state reliability of the scale; Pearson correlation coefficient is r=0,88. Prof. Dr. İsmet HASENEKOĞLU's affirmative opinions are taken for the content validity of the scale.

Teacher survey

As Teacher Survey a 20 item likert scale developed by Güveli (2004) is used. For reliability α value calculated as 0.99 (N=36). Prof. Dr. İsmet HASENEKOĞLU's affirmative opinions are taken for the content validity of the scale.

Teacher interviews

The interviews are summarised in RESULTS section.

RESULTS

Expert survey

Findings related to expert survey tabulated in Table 1. Expert hesitations about content order are self evident because the

subject matter is large. Subtitles are so overlapping that it is hard to find a single starting point. The content order in curriculum is tried to be followed.

Experts split into three equal groups according to their views about the number of exercises. Actually exercises are like examples and they aren't enough. It will be appropriate to increase their number for further applications.

Besides these the experts evaluate the material adequate in terms of: page design, running speed etc. To sum up experts confirm that the material is adequate on structural base, but there is –of course- room for improvement.

Table 1: Expert opinions about structural adequacy.

QUESTIONS	f / %	SA	A	nAoD	D	SD
1. Symbols, texts, colours and animations are chosen preoperly.	**f**	4	4	1	0	0
	%	44	44	11	0	0
2. Visual stress is adequate.	**f**	3	6	0	0	0
	%	33	67	0	0	0
3. Texts are legible.	**f**	4	4	1	0	0
	%	44	44	11	0	0
4. Screen can be used efficiently.	**f**	2	4	2	1	0
	%	22	44	22	11	0
5. Punctuation is adequate.	**f**	5	4	0	0	0
	%	56	44	0	0	0
6. Data presentation order is reasonable.	**f**	2	3	3	1	0
	%	22	33	33	11	0
7. Running speed is adequate.	**f**	3	5	0	0	1
	%	33	56	0	0	11
8. Content is pictured correctly.	**f**	3	5	1	0	0
	%	33	56	11	0	0
9. Pagination is adequate.	**f**	2	4	1	2	0
	%	22	44	11	22	0
10. Material is overt to improvement	**f**	3	3	3	0	0
	%	33	33	33	0	0
11. Material is attractive.	**f**	2	5	2	0	0
	%	22	56	22	0	0
12. Exercises are adequate.	**f**	1	2	3	2	1
	%	11	22	33	22	11
13. Buttons are suitable and work properly.	**f**	2	3	3	1	0
	%	22	33	33	11	0
14. Instructions are clear.	**f**	1	5	2	1	0
	%	11	56	22	11	0
TOTAL	**f**	37	66	22	8	2
	%	27	49	16	6	1

(**f**: frequency, **SA**: Strongly Agree, **A**: Agree, **nAoD**: Neither Agree or Disagree, **D**: Disagree, **SD**: Strongly Disagree)

Teacher survey

Teachers evaluate the material in educational point of view. *Teacher survey* results are presented in Table 2. All the teachers agreed that the material is attractive, easy to use and understand, which is good news for students. Most of the teachers content with the interactivity of the material and they think (94 agree, 6 abstain) that material would increase student interest, let student construct their own knowledge, provide suitable pre-organizing knowledge and self assessment opportunities. It is far form being a complete constructive one though. The teachers think that issues are presented in a logical order, instructions are clear, symbols, fonts, colours and animations are all well chosen. Some of the teachers think that there aren't enough exercises (13% disagree, 6% abstain) and some aren't sure (12% abstain) that exercise objectives may not be caught on easily by students. 81% of the teachers think that learning gains are conveniently embedded in the presentation. Whereas, 19% of them are abstainers. The links and buttons are reported to function properly. Material is unanimously evaluated as useful and potent to teach for "Nucleic Acids and Protein Synthesis" unit. 75% of them think that material is suitable for group activities (12% abstainer, 12% disagree). Actually this was not the one of the main concerns of it. The teachers evaluate the material as

it gives opportunity to use biology knowledge and logical conclusions (81% agree, 19% abstain). To be frank the main effort is spent for producing explanatory simulations. This played down the interactivity, student centred instruction and students' construct his own knowledge.

Considering the whole survey; the teachers evaluated material positively (%90) (8% abstain, 2% disagree) backed with these quantitative data.

Table 2: Teacher opinions about educational adequacy.

QUESTIONS	f / %	SA	A	nAoD	D	SD
1. Material lets pupils construct knowledge.	**f**	4	8	2	1	1
	%	25	50	13	6	6
2. Using the material is fun.	**f**	7	9	0	0	0
	%	44	56	0	0	0
3. Material employs interaction.	**f**	2	11	2	1	0
	%	13	69	13	6	0
4. Content is presented in a sensible order.	**f**	6	9	1	0	0
	%	38	56	6	0	0
5. Instructions and aids are clear.	**f**	5	10	1	0	0
	%	31	63	6	0	0
6. Symbols**,** texts, colours and animations are chosen preoperly.	**f**	6	9	1	0	0
	%	38	56	6	0	0
7. There are enough examples about the new knowledge gained.	**f**	4	9	1	2	0
	%	25	56	6	13	0
8. Inteded gains are embedded well into activities.	**f**	4	9	3	0	0
	%	25	56	19	0	0
9. Links run properly.	**f**	8	6	2	0	0
	%	50	38	13	0	0
10. This learning material is instructive for 'Nucleic Acids and Protein Synthesis'.	**f**	9	7	0	0	0
	%	56	44	0	0	0
11. The material is easy to use.	**f**	11	5	0	0	0
	%	69	31	0	0	0
12. Pupils have self-assessment opportunities.	**f**	6	9	1	0	0
	%	38	56	6	0	0
13. Knowledge, conceprs and rules are presented with proper metaphors, graphs and animations.	**f**	5	9	2	0	0
	%	31	56	13	0	0
14. The necessary preliminary knowledge is supplied.	**f**	7	8	0	1	0
	%	44	50	0	6	0
15. Hints and instructions are clear.	**f**	7	7	2	0	0
	%	44	44	13	0	0
16. Material will increase interest to subject matter.	**f**	10	5	1	0	0
	%	63	31	6	0	0
17. Texts diagrams and graphs are legible.	**f**	11	5	0	0	0
	%	69	31	0	0	0
18. Activities are suitable for both group and individual work.	**f**	3	9	2	2	0
	%	19	56	13	13	0
19. Material provides opportunity for reasoning and application of the biology knowledge.	**f**	5	8	3	0	0
	%	31	50	19	0	0
20. Material lets student associate new and former knowledge.	**f**	4	10	2	0	0
	%	25	63	13	0	0
TOTAL	**f**	124	162	26	7	1
	%	39	51	8	2	0

(**f**: frequency, **SA**: Strongly Agree, **A**: Agree, **nAoD**: Neither Agree or Disagree, **D**: Disagree, **SD**: Strongly Disagree)

Teacher interviews

First of all, all the teachers were pleased to try CABI. They like the job and gave sincere, detailed interviews. They offer a large set of scientific evaluation, correction and visualization ideas. They really led us to new horizons. They also present their recommendations about sturucture of the material.

The teachers remarked that; they are in favour of using the material in their instructions, such materials boost attention in classroom setting and make instruction more student-centred, and using them as assisting materials is a must even if they can hardly replace the role of teacher completely.

Most frequently mentioned teacher opinions are summerized and evaluated below;

There should be more University Elimination Examination (ÖSS) or similar questions.

It would be better if 'the gene' figure were given in chromosome magnification.

Some parts may not be explained in detail. But the material is thought as a supportive media. Hence, the teacher may assess the process formatively and help students to catch up with.

Improving buttons in terms of functioning is a must. For example a 'rewind button' for animations would reinforce understanding.

To symbolize purine bases with a double-ringed shape was a great idea missed for this time.

Expressed DNA segment is not in the form of stretched chromosome but chromatin threads instead. But in the simulation it is represented as the former. This is accepted as a best possible solution by simplification at the expense of explaining complex reality. We still had better remedy it for the next time.

Following; 'nucleic acids', 'protein digestion', 'protein synthesis' titles order is alleged to cause confusion. However the main focus of the material is to follow the whole path proteins following in the body.

The material looks like to take less than five class hours. On the other hand, curriculum offers more than three-fold of this figure for related units. This paradox prevents material from being the main reference. To use it for a review or using simulation parts during lectures is better.
We take these qualitative data valuable, rather than quantitative ones.

CONCLUSION and DISCUSSION

Material

First thing that should be concluded and reported frequently by teachers is material cannot be accepted as a complete student-centred one. It exposes knowledge to students without providing opportunity to reasoning and critical thinking, so it's getting boring. Actually the material is rather behaviouristic and it aimed to give knowledge to students directly. The material, on the other hand, presents simulations of complex biological phenomena and structures like; **chromosome structure, amino acid transportation, protein synthesis**. These parts are appreciated by the teachers and some other biologists. So to reduce the material into simulation parts seems a good idea for further applications.

Computer Assisted Instruction (CAI)

Most of the teachers think positive about CAI and supportive computer media. They remark that CAI materials increase interest and make instruction more student centred.

Suggestions

Based upon teacher interviews and survey; Computer Assisted (Biology) Instruction Materials, computer models and simulations boost learning. This conclusion complies with the previous domestic and international studies (Castleberry *et al*. (1973); Edwards *et al*. (1975); Aşkar and Köksal (1987); Bayraktar (1988); Sezer (1989); Hounshell and Hill (1989); Geban *et al*. (1992); Ozan (1993); Yalçınalp (1993); Ersözlü (1994); Zohar *et al.* (1994); Ritt and Stewart (1996); Lu, Voss, and Kleinsmith (1997); Asan (1998); Siegle and Foster (2000); Öztekin (2001))

There are few opposing results reported against the effectiveness of CAI and simulations implementation Summerlin and Marjorie (1971), Christmann *et al*. (1997), Güler (2002).

Proper Computer Assisted Biology Instruction (CABI) materials reinforce student learning and should be used in the instruction to support instructional activity. They are not to replace the teacher's role completely. Related infrastructure should be set at schools and teachers should be urged to use CAI materials. Ministry of National Education (MONE) should develop, distribute and encourage application of such materials.

CABI materials' content should be taken as narrow as possible to avoid overloading and boring pupils. If it is necessary to enlarge the content, separate units may be designed and there may be links between these units. The material had better to be designed as a supportive media presenting only parts hard to be imagined without visual aid. Computer should be valued as a device to tempt pupils' playing instinct –not a content loader. Moreover, enough room should be left for learner to construct his/her own patterns of learning.

The material should always excite the author. If not, it should be changed.

In this study, achievement tests haven't been applied neither the effects of the material over misconceptions of pupils. They are recommended for further and similar studies, after shaping the material under the light of the expert and teacher opinions.

Cross-cultural studies, achievement tests on this material are strongly urged. Provided you demand that after checking Turkish version of the material by asking for at meltimucin@yahoo.com or on www.tyfl.org under the heading of; "Biyoloji Belgeleri" and; "Protein Sentezi" subtitle (17.2 MB zip), then revised English version of the material will be provided. Further changes based upon recommendations are also welcome.

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