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Learning Portfolios and Interactive Examination in Periodontal Education

Abstract

The objectives of the project are to design and test a learning and examination system, which improves and supports the dental students' learning of Oral Biology and Clinical Periodontology. It is expected that the project will provide principles and methods for higher education of health professionals, who are better prepared for a work life than the present educational system is able to provide. The use of information and communication technology is a significant resource in the project. The project is focused on examination. Department chairmen will be interviewed during the spring 2003 concerning their attitudes towards the project and invited to participate using the basic methodology of the project but in their own subjects. Workshops during spring 2003 will be arranged together with dental students to discuss their opinions on the examination procedures and what resources the students consider relevant in the context. Contact has been taken with the director for Board of Education at the Centre for Oral Health. Collaboration with the School of Teacher Education and the Institute of Art and Communication at the Malmö University has been established as well. Internet based software has been written and tested for students' self-evaluation of clinical competence. These evaluations are used as instruments in the oral part of the interactive examination. Cases have been produced and tested for use in the examination. Software to facilitate the students learning and self-assessment has been designed (<http://www.tmk.odont.ku.dk/leo>). This latter internet based software is an instructional innovation. The software Ezone (<http://www.ezone.k3.mah.se>) at the Institute of Art and Communication Institute, Malmö University will be used for students' learning portfolios. There is a strong need, in classroom research, to develop and test examination forms which relates to the prevailing learning conditions and which evaluate various competences of the students in a coherent context.

Keywords: higher education, classroom research, instructional innovation, professional education, dental school, dental student, dentistry, licensing examination.

Report to the Council for the Renewal of Higher Education

The Interactive Examination.

A summative report of seven years of development and evaluation of an innovative assessment model in higher education.

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Abstract

The ability to self-assess one's competence is a crucial skill for all health professionals. The interactive examination is an assessment model aiming to evaluate not only students' clinical skills and competence, but also their ability to self-assess their proficiency. The methodology utilised students' own self-assessment, an answer to a written essay question and a group discussion. In five studies the role of Interactive Examination for learning and development of metacognitive skills in dental students was evaluated. Teachers' and students' acceptance of the methodology was very positive. The Interactive Examination appeared to be a promising tool for providing a deeper insight in student's ability to self-assess and steer their learning. Exploration of the entire potential of the interactive examination would require full implementation of the method in a given curriculum.

Introduction

Learning in academic settings is strongly related to the way the students are tested or examined (Schuwirth 2004). Moreover learning in any subject is influenced by the interaction between the learner and the learning resources (Wagner 1994). Despite the obvious relation between learning and mode of assessment, examinations in health care educations are often carried through as a simple control of the facts the students have accumulated during a given phase of the education. For example, multiple-choice question are often used. This mode of examination reflects the students' ability to recognize simple facts and does not address the necessary reflective capability of the students.

Modern healthcare environment requires that professionals are continuously developing their competence in all areas relevant to their expertise. This means that any curriculum in health care education must educate professionals who are not only competent in clinical procedures but also are prepared to adopt a practice of lifelong learning. Lifelong learning is a dynamic process, inseparable from daily professional practice, which can guarantee the provision of optimal and cost-effective healthcare, for the benefit of the patient and the society. The foundation of such an independent lifelong learning practice is the ability of the professional to self-assess his competence and continuously defines learning objectives.

It becomes therefore evident, that the self-assessment ability of the student must be also targeted by examination schemes, in parallel with knowledge and clinical skills. Training and assessment of self-assessment ability can be provided by using a dialogue principle in the education of the students. The dialogue principle would allow the teacher to obtain a deeper insight of the students' knowledge and reflective skills.

The Interactive Examination was developed in response to this need, as a structured assessment model that could assess students' reflective abilities in parallel to their knowledge and understanding of the respective subject. Furthermore, the methodology aimed to become an interdisciplinary learning experience, assisting students to train and further develop in the field of self-assessment. With the help of Information Technology and Internet, Interactive Examination aimed to become an independent learning tool, available to students and professionals independently of time and place.

The Interactive Examination was initially introduced in 1998 in the department of Periodontology, Centre of Oral Health Sciences, University of Malmö, replacing a conventional evaluation form. In the years that followed the methodology was further developed, applied and evaluated. The principles followed throughout the development process were flexibility, independence of specific instructional approaches, optimisation through Information Technology and interdisciplinary applicability. Distinct development directions included:

- a) Simplifying the logistics of the examination with the use of Information technology
- b) Enhancing interaction potential through Internet database-driven site
- c) Adaptation of the model for Distance Learning environments

- d) Adaptation for independent Internet-based training
- e) Application in different learning environments and educations.

The present report describes the Interactive Examination, the theoretical background and the educational principles that guide this form of examination. The report will follow the evolution of the methodology and describe the distinct development directions, as they were formed during the last seven years. Emphasis is given in the research data that have driven the development of the model since its introduction

The Interactive Examination in Periodontology

a. Initial examination model.

The initial model of Interactive Examination (Fig. 1) was introduced in 1998, replacing a traditional examination in Periodontology for 3rd semester students. The students were divided into groups of 7-8 students. Each group was assigned an examination session of about 4 hours. The examination was initiated by asking the students to evaluate themselves on various clinical competences in periodontology on a VAS scale ranging from excellent to poor with 6 alternatives. This self-evaluation was done prior to the actual examination. The students were then given one question in oral health provided with 10 keywords, which they were asked to use logically in their written response to the question. 45 minutes were allocated to respond to the question. The examiner thereafter initiated a discussion with each student based on his/her self-reported competence in oral health care. During the discussion, factors of importance in clinical periodontology were highlighted and illustrated. In the end of the examination session the students were given an expert answer to the question and asked to deliver a written comparison between their own answer and the expert answer. This comparison should specifically identify similarities and differences between the two answers to the question and should lead to the identification of future learning objectives. The comparison was to be delivered within 7 days by email. Within a month the students were given personal feedback on their performance by the examiner. The model in detail is described in Mattheos et al 2004.

The examination process is thus divided into four different phases:

1. Reflection, self-assessment
2. Written essay, oral examination- group discussion
3. Written comparison with the “expert”
4. Individual feedback and suggestions for improvement

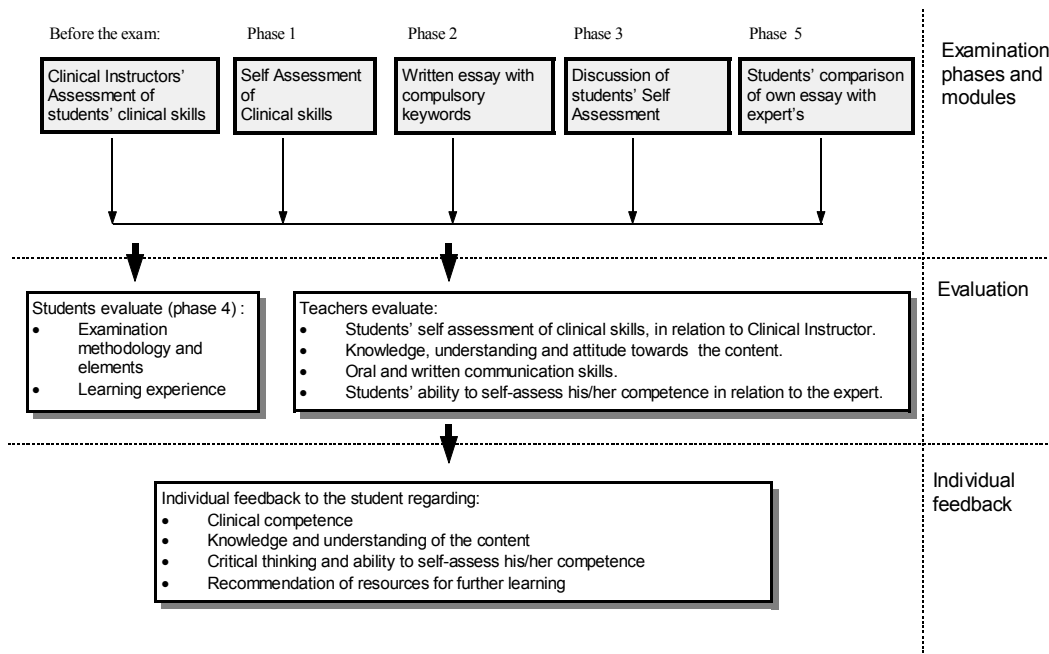


Figure 1. A schematic representation of the phases and processes of the Interactive Examination.

Strengths, conclusions and potential for further development.

Students' acceptance of the methodology was very positive. The most appreciated element of the examination was the discussion. Other elements were repeatedly commended as strengths:

- The opportunity to reflect on one's own self-assessment
- The effectiveness in helping identify one's learning needs
- The contact with the educators

The relaxed atmosphere of the examination also received favourable comment.

The differences identified by the students in their comparison document were classified in three major categories:

1. Differences in the form, such as differences in the language, length, style, essay format (plain text, mind map, flow chart, and so on)
2. Differences in content, such as omission or inclusion of certain points, clarifications, misunderstandings, and so on.
3. Differences in attitude towards the content, such as prioritising, elaborating, depth of detail, and so on.

In the majority of the comparison documents, a clear prioritising of the differences was observed. Matching the differences marked by students with the assessor's comments on their original written essay, the assessors were able to gain deeper insight into students' ability to identify potential weaknesses and consequently learning needs. In the majority of cases the students proved to be very skilful in locating the weak points and gaps in their knowledge. However, nine students (three females - six males) were in general unable to identify the actual problems with their essays. These students were provided with extra learning resources and asked to take part in a supplementary discussion

Weaknesses, fields for improvement.

The methodology proved to be demanding in terms of time and human resources. A specially demanding part was the personal feedback to students, which was at the same time one of the most appreciated elements of the methodology. The Assessors were convinced that the result was worth the time investment, as they felt they acquired unique insight into students' competence and self-assessment skills. However, it was clear that if the Interactive Examination is to expand be applicable to wider environments, a "rationalisation" of the time demands has to be considered, without jeopardising the level of interaction. It appeared that this was a problem calling for the added value of Information Technology (IT).

b. Introducing Information Technology support.

Web based driven self-assessment

Several IT based components were gradually introduced in an attempt to reduce the time- and workload for the assessors, as well as enhance the levels of interaction. A database Internet software was especially designed for the self-assessment part of the Interactive Examination. This application allowed expanding the assessment base and including students' clinical instructors in the process, at the side of the main assessors. The clinical instructors could now evaluate each student in the 11 competencies addressed by the learning objectives of the course. Afterwards each student undertook self-assessment of the same competencies through the programme. The students could also fill free text comments and reflect on their competence development during the semester. The database provided immediate, descriptive feedback to the student as to how his/her self-assessment relates to the evaluation by the instructor. Nobody but the student and the principle assessor had access to this feedback.

The objective of this automatic feedback was to provide each student with their clinical instructor's view on the students' competence levels in the various subjects

Content management system.

The Content Management System (CMS) (Webzone) of Malmö University was used to organise the logistics of the examination and keep track of students' progress according to the principles of portfolio assessment. The examination cases were presented, discussed and assessed through password protected Internet folders. Students submitted their written answers and comparison documents in their personal folders. Feedback and discussion took place through Internet, while the element of face-to-face group discussion was the conclusive moment in the end of the process.

The stand-alone application

Apart from the structured assessment process, it was apparent that IT opened up the possibility for the students to train on the assessment methodology through the same principles independent of time and place. Therefore a special Web-based application was programmed which contained a wide selection of clinical problems based on actual patient cases. The site was available on the Internet for all students, helping them to train on self-assessment skills at their own pace. This site did not aim to replace the formal examination process of the human feedback, but rather to help students familiarise with the principles and direct them towards improving their self-assessment skills in parallel to their knowledge and competences. The initial programme was called LEO (Learning on Line, <http://cert.od.mah.se/leo>). A further implementation of more levels and an improvement of the user interface lead later to the creation of the learning site SELF (<http://www2.od.mah.se/self>), which is planned to be used by the Danish Dental Association for continuous education of dentists. Both sites are still available free on the Internet and are used by a wide variety of registered users.

Strengths, conclusions and potential for further development.

The process of introducing IT support to the methodology significantly increased the impact of the methodology and improved many of the practical weaknesses of the initial approach. The introduction of the database driven self-assessment components widened

the basis of the assessment by involving the clinical instructors in the process. It also increased the potential of the interaction and the quality of student reflection, as it was shown that students reflection were richer and deeper when they were allowed to do this at their own time and pace through internet and not during 20 minutes in the classroom as it was initially practiced. In addition, having all judgements from clinical instructors and students saved in a database allowed for a whole new potential of understanding of the process. On an individual basis, significant deviation between the instructors' and the students' assessment stimulated discussions which helped students and assessors clarify many misunderstandings and improved communication during clinical practice. From a macroscopic point of view, such deviations provide us with useful information for curriculum development and planning. The introduction of the CMS allowed for an expansion of the assessment from a one-shot process at the end of the semester to a progressive path throughout the semester, where multiple cases were discussed and clear improvement pathway was possible to demonstrate. The addition of LEO and SELF allowed interested students to further train at their own path and initiative.

Furthermore, the IT enhancements resulted in a significant reduction of the workload, by automating part of the feedback and by streamlining the process. Interaction was enhanced and the time needed for the actual face-to-face conclusive phase was now decreased by half, while still preserving the valuable element of group discussion.

Weaknesses, fields for improvement.

The benefits of introduction of IT by far outweighed the disadvantages. Still some problems were experienced in relation to the Computer literacy of certain students and their hesitation to fully utilise the potential given by the IT. It was also observed that certain students experienced the feedback coming from the comparison with the instructors as a “judgement” and were discouraged if they would notice deviations. Although these deviations were meant to be hints for discussion, by some students they were experienced as a failure.

c. The Distance Learning model

Encouraged by the results of introducing IT in the process, the next step was to attempt a new version of the assessment, fully based on IT and available to students at a distance. This would imply that the whole process, from the self-assessment to the final group discussion would be undertaken through Internet. The model would remain essentially the same, but the final group discussion would be undertaken through Internet-based Videoconference. To study this option, a randomised controlled trial was organised (Mattheos et al 2003). The students were organised in 5 groups, two of which (n=15) were assessed through the procedure, while three (n=24) took the exam through Internet-based teleconference.

Strengths, conclusions and potential for further development.

The technology proved to be functional and reliable. It was evident that free, Internet-based communication technology was mature enough to facilitate the communication necessary for the examination. The acceptance of the Interactive Examination was still very positive and there was no significant difference existed in the performance of students between local and teleconference settings.

Weaknesses, fields for improvement.

There was significantly less satisfaction with the examination within the teleconference group. Students in the local settings group emphasized that interaction was one of the major strengths of the methodology, but interaction appeared less appreciated by the teleconference group. Apparently the students that took the exam through teleconference felt less secure with the process and considered this a more stressful experience. The reasons for this difference are hard to identify. Students were previously exposed to teleconference teaching with good results, but it appears that they are less willing to accept teleconference for the more sensitive process of an examination. The physical presence of the assessor and the unhindered body language might work reassuring for the students, decreasing their fear of being misperceived. At the basis of these findings it was concluded that Internet based teleconference can successfully facilitate a highly structured assessment model, but apparently the face-to-face discussion seemed to be the most appropriate option at present, so no further development occurred towards this direction.

d. The importance of human feedback

Another distinct direction of development was this of the stand-alone applications such as LEO and SELF. Their contribution towards preparing students for the examination was significant, it relied a lot however to time wise costly individual feedback from the assessor. It was therefore interesting to investigate whether such applications could help students develop their self-assessment skills, even when feedback from the assessor was not available. To investigate this issue a randomised controlled trial was designed (Mattheos et al 2004b).

Fifty-two students were randomised into an experimental and a control group. Both groups went through four identical learning cases in Periodontology during a period of 1 month. The experimental group received the cases through LEO, while the control group received them through a simple static web page. Both groups received no feedback from the assessor during the process. After the end of the learning phase, two assessors assessed both groups blindly using the interactive examination methodology.

Strengths, conclusions and potential for further development.

There was a moderate agreement between the two assessors, but both failed to find any significant differences between the two groups with regard to self-assessment skills and overall performance of the students. Students positively received the Internet support, but several attitude differences were observed between the two groups during the study. Time on task and competence with computers were positively correlated to assessment results for both groups.

Weaknesses, fields for improvement.

On the basis of these findings, it remains unclear if computer-based applications with automated feedback can constitute an effective remedial support for the improvement of self-assessment skills of students. Human individualised feedback seems to be irreplaceable part of the process of developing self-assessment skills. This study indicated that further reduction of the workload through eliminating human individualised feedback might impact the potential of the learning process and therefore feedback should be at present as a critical component.

e. The long-term follow-up

The expansion of the Interactive Examination to the Comprehensive Care Clinic (senior students) in 2004, allowed for a long-term research follow-up evaluation (Mattheos 2005). Very little can be found in the literature on how students' self-assessment ability evolves throughout the curriculum and this study allowed us to evaluate the long-term impact of the Interactive Evaluation. One cohort of dental students (n= 48) underwent assessment through Interactive Examination at three instances in 2004, during their final year of studies. Forty-two of them were assessed with the same methodology in 2001. Students' individual performance, self-assessment ability scores and attitudes in 2004 were correlated with their respective data from 2001.

Strengths, conclusions and potential for further development.

Students' acceptance of the methodology was high. All stages in 2004 were assessed by a different assessor than in 2001. There was an interesting correlation of students' self-assessment ability in 2004 with this in 2001. Five students presented inadequate self-assessment abilities in 2004, 4 of which were also inadequate in 2001 in the same areas. Although the self-assessment ability of the whole cohort was significantly improved, inadequate students of 2001 (n=9) presented significantly lower results than their colleagues in 2004. These observations indicated that the self-assessment ability is not directly correlated with subject knowledge; for most students self-assessment is a skill that develops throughout the curriculum. However, even by graduation, there are still a number of students that significantly deficient in self-assessment skills, the majority of whom could have been identified earlier in their studies. Based on this study, the Interactive examination could detect these weak students already three years before graduation with a sensitivity of 80% and a specificity of 86%.

Weaknesses, fields for improvement.

The study provided a unique insight in long-term development of self-assessment skills. However, differences in the methodology between 2001 and 2004, differences in the environment and the cases limit the impact of the results. Further prospective intervention studies are needed to clarify these findings and attempt to answer the question if and how specially designed and regular remedial interventions can help weak students to develop an acceptable level of self -assessment ability before graduation.

Application in different environments

a. The early undergraduate environment

The methodology was initially applied and evaluated with dental students in their third semester of studies, as described in previous paragraphs. This phase of the study program is special because it is here that the student should be building both a comprehensive knowledge and theoretical base, while also includes the development of a set of specific clinical skills. As such, this part of their studies requires the students to display competence in multiple levels, but the self-assessment process is still supported by clearly defined learning objectives

b. The late undergraduate environment: Comprehensive Care Clinic

The Interactive Examination was introduced in 2004 into the Comprehensive Care Clinic, the last stage of training the students receive before graduation. This environment is by far more complex than that in the third semester. At this stage, students have to treat complex patient cases and the knowledge base expands well over the whole domain of academic healthcare education. The students here are expected to demonstrate a wider understanding; show their initiative and ability to evaluate treatment options suggested by others as well as to continuously self-assess their performance. There is a strong problem based orientation. The Interactive Examination has proved to be an especially appropriate assessment method for this environment. Certain modifications were introduced in order to emphasise the clinical orientation of the assessment and to integrate the assessment methodology with the clinical seminars of the students. Further details on this model are reported by Mattheos et al (2005). The Interactive Examination is successfully used for a third year in the Comprehensive Care Clinic and further research is planned.

c. Teacher education

Interactive Examination was adapted by the Education faculty for the assessment of first year teacher students. In this particular model, student teachers went through several problem cases described by small video sequences and then followed the Interactive Examination process through Malmö University's CMS. Further description of this model, as well as a comparative study between dental and teacher students in the Interactive Examination are available in Jonsson et al (2005).

d. International environments.

Interactive Examination has been applied to the assessment of undergraduate dental students in Brescia, Italy and orthodontics residents in Cardiff, UK. Toni et al (2003) discuss these experiences.

Discussion

The present series of project reports indicate that the Interactive Examination model handles a difficult problem often encountered in traditional assessment methods. The traditional examination generally focuses on comprehension of knowledge and skills but limited attention is addressed to important aspects of an academic education. Skills like critical thinking, ability to undertake realistic self-evaluation and identification of own learning needs are seldom given priority in traditional assessment methods. Frequently, even multiple choice questions are used in testing of knowledge and skill in health educations. Such examination is characterized by simple recognition with few elements of understanding and attitude testing. Relevant assessment of knowledge and skills should be the primary aims of any assessment method in health education. It is our firm conviction that unless a methodology to assess self-directed learning related skills is introduced little insight will be gained in the effectiveness of academic teaching for generating appropriate learning attitudes among future health professionals.

Our studies indicate that assessment should be a dialogue between the examiner and the student. The introduction of a dialectic form of evaluation in which the self-assessment becomes the initiator for the student's critical thinking about his or her own theoretical and clinical competence. All involved resource persons should be engaged in this dialogue. The most important contribution a dialogue based approach can make is that it introduces a learning potential into the assessment situation which shifts the focus of away from a previous almost exclusive focus on summative assessment/examination (Boud, 1986). Therefore, the aim of the Interactive Examination is to shift student's focus from "How good am I?" to "How can I get better?" (Brown, 1997). Students must reflect and elaborate on their self-judgements and use this assessment as the starting point for a dialogue (Boud, 1986). When this dialogue is carried out in a group, group dynamics and peer assessment aspects are also introduced. However, one must be cautious of personal or cultural barriers, which might hinder some students to properly discuss their competence in front of their peers (Morreale, 1992).

Self-assessment and instructors' role

Comparing students' self-assessment with that of tutors/instructors may have multiple functions. On an individual basis, significant deviation between the instructor's and the student's assessment can stimulate discussion, although it is important to clarify that the deviation itself does not constitute a judgement of any kind. When such discussions took place, both students and instructors reported them as very beneficial. From a macroscopic perspective, such deviations provide us with useful information for curriculum development and planning (Ries, 1971; Milgrom, 1978; O'Neil, 1985; Ericson, 1997; Das, 1998). The identification of clinical areas where students' self-assessment significantly varied from their instructors provides educators with an opportunity to re-evaluate their teaching methodologies for specific skills in their respective fields.

During our systematic evaluation of the Interactive Examination it was observed that students systematically overestimated their competence in four fields, all of which related to diagnostic rather than therapeutic procedures. This fact might reflect an important "trend". As reported by their clinical instructors, students of that level often tend to rush

and simplify the diagnostic and treatment planning procedures, overemphasising the importance of clinical skills. Alternatively, potential diversity of teaching methodologies or too high expectations from the side of the clinical instructors might be also a cause for these diversities between students' and tutors assessment.

Comparison with an “expert”

The “comparison with the expert” task is a critical part of the examination. The “expert” document serves as an immediate feedback, forcing students to reflect and elaborate in written on their self-perceived competence. Through the qualitative evaluation of the comparison documents, assessors could acquire a deeper insight in students' reasoning and priority setting skills, as well as their ability to benefit from feedback and identify their learning needs. This way the assessor can come up with constructive secondary feedback to the student that will hopefully result in improvement of the respective skills.

Feedback – follow up

In a few cases students presented several weaknesses in relating their perceived competence to the expectations of the assessors and appeared unable to locate the gaps in their understanding of the content or prioritise. Rather than “failing” an exam, these students were provided with some extra tasks and were invited to an additional discussion after they had received their individual feedback. In the future, supportive tasks focused on independent learning and frequent follow-ups, might help these students to develop their self-assessment skills to a satisfactory degree (Roger, 2001).

“Stand-alone” software as remedial support

There is no doubt that the interactive examination is a demanding methodology in terms of staff/hours, at least when compared with more traditional assessment methods. In an attempt to reduce this workload for the staff, an adaptation of the Interactive Examination methodology for a stand-alone software application was developed and evaluated. This software did not aim to replace the Interactive Examination, but rather to constitute a convenient remedial support or “training” for students in need. Despite their moderate agreement, both assessors found no significant difference between the performances of students who used this software in comparison to those who used a static web page. Stand-alone computer applications have been reported successful in improving student competence in areas such as knowledge comprehension, clinical skills (Kaufmann, 2001), communication skills (Konkle-Parker, 2002), etc. In such applications, the software was able to provide constructive feedback pointing out the actual mistakes made. However, when it comes to complicated cognitive procedures (critical thinking, problem solving, self-assessment) computer generated feedback does not point out actual weaknesses, but rather provides a flexible example or standard. The subsequent student reflection is expected to result in improvement of the skill in question. Such an assumption is encouraged by recent theories in cognitive science (Landauer, 1997; Landauer, 2002), but research in this area is still at an early stage.

It is interesting that in this study time on task appeared connected also with the self-assessment skills, at least for one of the two assessors. The variation between individuals regarding time was extreme, not only between the groups but also within each group. It's

unclear whether such findings indicate cause-effect relationships, or simply appear due to confounding factors. For example, more motivated and knowledgeable students who would have a better performance in the exams are also likely to devote more time on the Internet than those less interested in the subject. The correlation between computer competence and performance might be well attributed to a similar dependence on confounding factors.

Students' acceptance and strengths of the interaction.

The acceptance of the Interactive Examination was very positive among the students. The high ratings were supplemented by many positive comments where students expressed their especial appreciation of the oral part and the discussions within the group. This increased appreciation of the discussion element might be the key to understand the results of the teleconference experiment (distance learning model) as students participating in this study demonstrated a clear preference towards in-person assessment than via teleconference.

Although the technology lived up to our initial expectations, the teleconference students were less positive towards the whole experience. It is important to note that the methodology, the physical space and the amount of time spent on each group was the same and there were not any direct faults or failures of the technology reported to which this attitude could be attributed. These findings are reinforced by students' free text comments, as students of the control group appear clearly in favour of the discussion part, something not apparent at the experimental group. Although research in the area of assessment is still limited, previous controlled studies also reported lower acceptance of teleconference as a medium for examination (Chi, 2002), or lower scores by students examined this way (Novack, 2002).

Several factors might be responsible for the lower acceptance of the teleconference-based version of the examination. It is well evident that every instance of assessment is accompanied by a certain degree of stress for students, which can vary considerably between individuals (Iumatov, 2001). Personal contact with an experienced examiner throughout the examination might have acted reassuring for the students, either by increasing their confidence or by relieving some of their examination stress. On the other hand, contact through teleconference settings, where body language is hindered (Chi, 2002) and communication is mediated mainly through a screen might have deprived students of the reassurance of direct contact with the examiner and increased their fear of misunderstanding. Alternatively, one might suspect that teleconference settings per se can act as a stress factor for a group of students unfamiliar to these applications. The degree of stress or discomfort induced by an examination situation might directly affect students' satisfaction and acceptance of the experience, although this has not been found to significantly affect actual performance in the examination (Arndt, 1986; Briese, 1995).

The generic potential of IE as an examination methodology

The evaluation of IE in the teacher education context demonstrates that the principles of IE are applicable also to subjects outside health sector. These observations indicate that IE may be a generic tool to stimulate students' metacognitive skills in academic settings

(educations). Future studies should be focused on the role of IE for developing these skills over time. Also the potential for IE to identify students in need for special support in their studies should be investigated.

The predictive value of IE

The results of study of the students' performances in IE during their 3rd and 9th semester indicate that the performance during the 3rd semester is predictive for the individual student's achievements during the 9th semester. It should be noted that both the subject of examination and the teachers were different at the two examination occasions. The predictive potential of IE was an unexpected finding and should be explored further.

Other issues

The presence of resource persons and the immediate feedback helped many students perceive this assessment "as a learning experience rather than examination", as it was repeatedly stated. The presence of external "resource persons" did not appear to affect students' performance or convenience in the discussion. However it was made explicit that resource persons were experts coming to contribute their knowledge and not examiners.

Students' agreement with their clinical instructors judgements in the systematic evaluation (database driven computerised self-assessment), appears to be lower than the ones reported in previous research (Arnold, 1985; Nathan, 1992; Fincher, 1993), including a study in the same centre (Ericson, 1997). In addition, in the present study students appear to overestimate their competence rather than underestimate it, which contradicts several previous studies. The ordinal scales used in different studies are not directly comparable and the number of stages provided (usually varying from 3 to 7) appears to affect the degree of agreement observed. Typically, the smaller the scale, the higher the level of agreement observed (Ericson, 1997). However, the tendency to either overestimate or underestimate is not affected by the ordinal scale and observations of this kind could be considered as valid. The students' overconfidence appearing in this study might be attributed to the early timing of the observation in the curriculum (3rd semester), while the previous studies mentioned involved interns, residents (Nathan, 1992; Fincher, 1993) or students in later semesters of their studies (Ericson, 1997). There is indication that beginners tend to overestimate their competence, while more mature learners underestimate it (Brown, 1997). The qualitative aspect of the deviation is also important, as students' overestimation of competence tends to be focused in diagnostic rather than treatment skills and procedures. Therefore, it will be of special interest in future research to relate the deviation between students and instructors not only to the various characteristics of the students (age, gender, year of studies), but also to the nature of the skills or competencies under evaluation, an aspect not adequately brought up in contemporary research.

Gender differences in self-assessment patterns are a controversial issue in the literature. Some studies in the past have reported higher agreement between student self-assessment and teacher judgements among female students (O'Neil, 1985; Ericson, 1997). Others have found no significant difference (Arnold, 1985). In the present study female students

performed significantly better in the oral and written parts of the exam and they were significantly underrepresented in the group of students that was called again. It should be also noted that the majority of clinical instructors were females. The difference in performance between females and males should be explored further in order to identify cultural and motivational factors of importance for the learning process

In conclusion, the Interactive Examination appeared to be a promising tool for providing a deeper insight in the student's ability to self-assess himself or herself and steer their learning. Exploration of the full potential of the interactive examination would require full implementation of the method in the curriculum. Studies of the relative importance for learning of the various components of the Interactive Examination should be analysed in different educational settings. Conscious self-evaluation of knowledge and skills might be a crucial instrument for stimulation of life-long learning in health professions.

Acknowledgement

The project group expresses their sincere appreciation to the Council for Renewal of Higher Education, National Agency for Higher Education, Stockholm, Sweden. The advice and support from the staff at the council in particular Åsa Rurling, Peter Gates Anna Lundh, Göran Petersson and late Hans Jalling is greatly appreciated. The former National Council for Distance Education (DISTUM) and especially Carl Holmberg and Henrik Hansson, for their very constructive feedback and their full hearted support throughout the project. Eva Falk-Nilson and Professor Hal Lyon for the generous contribution of their expertise in matters of pedagogy. The Council as well as the Faculty of Odontology Malmö University, which have continuously supported the project Interactive Examination. We also express our gratitude to Björn Lundgren and professor Gunilla Svingby for support and contributions with suggestions for development of the project. The collaboration with Lars Rauer and Mikael Rundegren at the School of Arts and Communication, Malmö University is also greatly appreciated. We also extend our thanks to Anita Toräng and Eva Karlsson at the Faculty of Odontology for tireless support with administration and logistics of the project

References

- Schuwirth L, van der Vleuten C. (2004). Changing education, changing assessment, changing research?. *Med Educ* 38: 805-812.
- Arndt CB, Guly UM, et al. (1986). "Preclinical anxiety: the stress associated with a viva voce examination." *Med Educ* 20: 274-80.
- Arnold L, Willoughby T, et al. (1985). "Self evaluation in undergraduate medical education: a longitudinal perspective." *J Med Educ* 60: 21-28.
- Boud D (1986). *Implementing student self-assessment*. Sydney.
- Briese E (1995). "Emotional hyperthermia and performance in humans." *Physiol Behav* 58: 615-8.
- Brown G, Bull J, et al. (1997). Peer and self assessment. In: *Assessing student learning in higher education*. London, Routledge: 170-184.
- Chi C, Chang I (2002). "Realtime telemedicine for teaching a first aid course." *Telemed Telecare* 8: 36-40.
- Chinnock C (1994). "Virtual reality in surgery and medicine." *Hosp Technol Ser* 13: 1-48.
- Das M, Mporfu D, et al. (1998). "Self and tutor evaluations in problem-based learning tutorials: is there a relationship?" *Med Educ* 32: 411-418.
- Epstein L, Northrup R (1994). "The students' role in assessment: Building a progression in problem -based learning." *Annals Community-Oriented Education* 7: 389-398.
- Ericson D, Christersson C, et al. (1997). "Clinical guidelines and self-assessment in dental education." *Eur J Dent Educ* 1: 123-8.
- Falchikov N, Boud D (1989). "Student's self assessment in higher education: a meta analysis." *Review of Educational Research* 59: 395-430.
- Fincher R, Lewis L, et al. (1993). "Relationships of interns' performances to their self-assessments of their preparedness for internship and to their academic performances in medical school." *Acad Med* 68:2 Suppl: 47-50.
- Goldenberg D, Beyar R (2000). "The medical school Web site: medical education's newest tool." *Isr Med Assoc J* 2: 797-800.
- Gul Y, Wan A, et al. (1999). "Undergraduate surgical teaching utilizing telemedicine." *Med Educ* 33: 596-599.
- Gul Y, Wan A, et al. (1999). "Use of telemedicine in undergraduate teaching of surgery." *Telemed Telecare* 5: 246-248.
- Iumatov EA, Kuz'menko VA, et al. (2001). "[Emotional stress in students during examination]." *Fiziol Cheloveka* 27: 104-11.
- Jönsson A, Mattheos N, Svingby G, Attström R. (2005) *The Interactive Examination in teachers' and dental education. A comparative study on an innovative assessment model. Assessment and Evaluation in Higher Education*, submitted September 2005.
- Kaufmann C, Liu A (2001). "Trauma training: virtual reality applications." *Stud Health Technol Inform* 81: 236-41.
- Konkle-Parker DJ, Cramer CK, et al. (2002). "Standardized patient training: a modality for teaching interviewing skills." *J Contin Educ Nurs* 33: 225-30.
- Landauer T (2002). On the computational basis of learning and cognition: Arguments from LSA. In: *The psychology of learning and motivation*, **41**: 43-84.

- Landauer T , Dumais S (1997). "A solution to Plato's problem: The Latent Semantic Analysis theory of acquisition, induction and representation of knowledge." *Psychological Review* 104: 211-240.
- Landis R , Koch G (1977). "The measurement of observer agreement for categorical data." *Biometrics* 33: 159-174.
- Mattheos N (2004) Information technology and interaction in learning. Academic dissertation, Malmö University ISBN 91-628-5980-3
- Mattheos N, Jönsson J, et al. (2000). Technology and media for distance learning in academic health education.
- Mattheos N, Nattestad A, et al. (2003) "Feasibility and satisfaction with the use of low bandwidth videoconferencing for examination of undergraduate students." *Journal of Telemedicine and Telecare* 9: 278-281.
- Mattheos N, Nattestad A, et al. (2004) "The Interactive Examination: assessing students' self-assessment ability." *Med Educ* in press, 2004.
- Mattheos N, Nattestad A, Christersson C, Jansson H, Attstrom R (2004)b. The effects of an interactive software application on the self-assessment ability of dental students. *European Journal of Dental Education*, in press 2004.
- Mattheos N, Leisnert L, Attström R. (2005). The Interactive Examination in Comprehensive Dental Care Clinic. A three year follow up of students self-assessment ability. *Med Teach*, submitted July 2005.
- McGee JB, Neill J, et al. (1998). "Using multimedia virtual patients to enhance the clinical curriculum for medical students." *Medinfo* 9: 732-5.
- Milgrom P, Weinstein P, et al. (1978). "Dental examinations for quality control: peer review versus self-assessment." *Am J Public Health* 68: 394-401.
- Morreale, Sherwyn, et al. (1992). Oral Communication Competency Assessment: Cultural Diversity, Ethnicity, and Students At-Risk. 78th Annual Meeting of the Speech Communication Association, Chicago, IL, .
- Nathan R , Mitnick N (1992). "Using an in-training examination to assess and promote the self-evaluation skills of residents." *Acad Med* 67: 613.
- Novack D, Cohen D, et al. (2002). "A pilot test of WebOSCE: a system for assessing trainees' clinical skills via teleconference." *Med Teach* 24.
- O'Neil G (1985). "Self, teacher and faculty assessment of student teaching performance. A second scenario." *Alberta J Educ Res* 31: 88-98.
- Ries A, Kreit L, et al. (1971). "A comparison of dental student self-evaluations with predicted and actual teacher evaluations." *J Dent Educ* 35: 493-495.
- Roger V, Rohlim M, et al. (2001). Assessment Methods. In: *Dental Education in Europe: Towards Convergence*. S. BD. Budapest, Dental Press kft: 100-109.
- Schitteck M, Mattheos N, et al. (2001). "Computer assisted learning. A review." *Eur J Dent Educ* 5: 93-100.
- Taras M (2001). "The Use of Tutor Feedback and Student Self-assessment in Summative Assessment Tasks: towards transparency for students and for tutors." *Assessment & Evaluation in Higher Education* 26: 605-614.
- Tatti P , Lehmann ED (2001). "Use of the AIDA diabetes simulation software -- www.2aida.org-- as an interactive educational tool for teaching student nurses." *Diabetes Technol Ther* 3: 655-64.

Tonni I, Oliver R. (2003). Assessment of competencies for the specialist orthodontist. Proceedings 29th Meeting of the Association for Dental Education in Europe, Dresden, Germany 3–6 September 2003.

Wagner E (1994). "In support of a functional definition of Interaction." *The American Journal of Distance Education* 8: 6-29.

Appendix

Research Evaluations of the Interactive Examination:

Published studies

1. Mattheos N, Leisnert L, Attström R. The Interactive Examination in Comprehensive Dental Care Clinic. A three year follow up of students self-assessment ability. Med Teach, submitted July 2005.
2. Jönsson A, Mattheos N, Svingby G, Attström R. The Interactive Examination in teachers' and dental education. A comparative study on an innovative assessment model. Assessment and Evaluation in Higher Education, submitted September 2005.
3. Mattheos N, Jönsson A, Svingby G, Attström R. Dynamic Assessment and Interactive Examination. 11th Biennial Congress of European Association for Research in Learning and Instruction, Cyprus August 2005.
4. Mattheos N, Nattestad A, Christersson C, Jansson H, Attstrom R.
The effects of an interactive software application on the self-assessment ability of dental students. Eur J Dent Educ 2004, Eur J Dent Educ 2004: 8 :97-104. [PubMed](#)
5. Mattheos N, Nattestad A, Falk Nilsson E, Attstrom R. The Interactive Examination: Assessing students' self-assessment ability. Med Educ 2004: 38: 378-389. [PubMed](#)
6. Mattheos N, Nattestad A, Attstrom R. Feasibility of and satisfaction with the use of low-bandwidth videoconferencing for examination of undergraduate students. J Telemed Telecare, 2003: 9: 278-281. [PubMed](#)
7. Information Technology and Interaction in Learning. Studies of Applications in Academic Oral Health Education. Academic dissertation, Holmbergs, for Malmö University, 2004. ISBN: 91-628-5980-3

Abstracts – Congress Proceedings

1. Mattheos N, Attström R. Interactive examination: assessing students' self-assessment ability in a Problem Based Learning curriculum. Proceedings of the 30th Congress of the Nordic Association of Pedagogic Research, Tallinn March 2002.
2. Mattheos N, Attström R. Replacing human feedback with Internet-Based methodology in the training of self-assessment skills. A randomized trial. Proceedings of XII Congress of the European Distance Education Network, Rhodos June 2003. Chair: Erwin Wagner.
3. Mattheos N, Nattestad A, Schitteck Janda M, Attstrom R. A structured examination approach for assessing students self assessment abilities. 81st Annual IADR Congress, Gothenborg 2003. Abstract available at J Dent Res 82(Spec Iss B) 2003: p311.
4. Tonni I, Oliver R. (2003). Assessment of competencies for the specialist orthodontist. Proceedings 29th Meeting of the Association for Dental Education in Europe, Dresden, Germany 3–6 September 2003.

5. Mattheos N, Attström R. learning through examination dialogues. Dialogues in Learning International Conference, Malmö 2003. Chair: Professor Gunilla Svingby.

6. Mattheos N, Nattestad A, Attström R. Interactive Software vs. static web pages in undergraduate Periodontology education. (83rd IADR Congress, Honolulu 2004. Abstract available at J Dent Res 83(spec iss).

Spin-off free products:

1. LeO (learning On-line) at <http://cert.od.mah.se/leo>

2. SELF <http://www2.od.mah.se/self>

Different environments where the method was applied

1. Malmö University, third semester dental students, 1998-2005

Rolf Attström, Nikos Mattheos

2. Malmö University, senior dental students, 2004- present

Leif Leisnert

3. Malmö University, first semester teacher students, 2004 – present.

Anders Jönsson, Gunilla Svingby

4. University of Brescia, IT, undergraduate dental students, 2002

Ingrid Tonni, Corrado Paganelli

5. University of Cardiff, UK, orthodontics residents 2003

Ingrid Tonni, Richard Oliver