

Assessment report
Limited Framework Programme Assessment
Bachelor Chemical Science and Engineering
University of Twente

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1. Executive summary

In this executive summary, the panel presents the main considerations which led to the assessment of the quality of the Bachelor Chemical Science and Engineering programme of University of Twente. The programme was assessed according to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, published on 20 December 2016 (Staatscourant nr. 69458).

The panel considers the programme objectives to be sound and welcomes the broadness of the programme, educating students in the disciplines of chemistry, materials science and process technology. The programme addresses very well both the molecular and technological dimensions of the chemical engineering field. This Bachelor programme and the subsequent Master Chemical Engineering allow students to be broadly educated in this field and to select one of the specialisations in the Master programme. The panel considers this bachelor-master trajectory to be a very valuable concept. The panel appreciates students being offered the opportunities to develop their skills as researchers or as designers/engineers or as managers/organisers.

The objectives of the programme are within the boundaries of the domain-specific reference framework for academic chemical sciences programmes. The panel appreciates the efforts by the joint programmes in chemical sciences in the Netherlands to draft this framework and regards this to be a sound and up-to-date description of this domain. The profile of this University of Twente programme may be clearly distinguished within the framework.

The panel understands and supports the programme position to educate students to continue their studies at master level and not so much to enter the labour market. The panel advises, however, to state future trends, relevant for the programme, in more clear terms to allow the programme to adjust to these trends.

The intended learning outcomes match the programme objectives, are very clearly and very explicitly formulated, meet international frameworks and conform to the bachelor level.

The panel regards the number of incoming students adequate, being within programme capacity limits, but understands programme management's intentions to raise this number to about 70 students per year.

The curriculum matches the intended learning outcomes of the programme. The panel appreciates the curriculum contents, especially the transformation to Twente Educational Model-modules, noting the courses to be solid in terms of contents. The panel regards the curriculum to be research-based and to be up-to-date, new trends being incorporated. The curriculum is coherent, the Twente Educational Model structure being welcomed by the panel. The panel is positive about the academic and professional skills being addressed. The panel proposes to adapt the mathematics courses more to the programme contents.

The panel found the lecturers a very motivated and enthusiastic team, their educational capabilities and research track records being up to standard. The panel experienced strong alliance in views on the programme between programme management and lecturers. The panel notes the capacities of the lecturers to be very much appreciated by students.

The entry requirements and admission procedures of the programme are appropriate.

The panel welcomes the educational concept and the study methods of the programme promoting students to actively engage in the learning processes. The panel finds the number of lab courses adequate. The students-to-staff ratio and the number of hours of face-to-face education meet the standards. The study guidance is adequate as well. Although the programme is challenging, the panel considers the programme to be feasible and the study load to be evenly distributed. The student success rates are appropriate.

The examination and assessment policies of the programme are appropriate. The position and authority of the Board of Examiners are adequate, the Board being very serious and very professional in executing their duties. The panel approves of the examination methods and notes these to be consistent with the goals and the contents of the courses. The panel supports programme management's intentions to prevent free-riding in group projects and assignments. The panel is pleased to see academic and professional (soft) skills being assessed and encourages programme management to develop and assess these teaching-learning trajectories through the curriculum more systematically. Students are offered appropriate supervision for the Bachelor assignments. The assessment procedures are up to standard, the assignment committee involving at least three examiners and being conducted using scoring forms with relevant criteria. The measures taken to ensure the validity, reliability and transparency of examinations and assessments are adequate. The panel suggests to strengthen the peer review of examinations.

The panel regards the examinations of the courses to be up to standard. The panel supports the grades awarded to the Bachelor assignments by the programme examiners. The panel regards these assignments to be well-elaborated and to be solid in terms of theory and methodology.

The panel is convinced that students having completed the programme reached the intended learning outcomes and regards the graduates of this programme to be well prepared to continue their studies at master level in this domain.

The panel which conducted the assessment of the Bachelor Chemical Science and Engineering programme of University of Twente assesses this programme to meet the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, judging the programme to be good. Therefore, the panel recommends NVAO to accredit this programme.

Rotterdam, 5 February 2019

Dr. C. Terlouw
(panel chair)

drs. W. Vercouteren
(panel secretary)

2. Assessment process

The evaluation agency Certiked VBI received the request by University of Twente to support the limited framework programme assessment process for the Bachelor Chemical Science and Engineering programme of this University. The objective of the programme assessment process was to assess whether the programme would conform to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, published on 20 December 2016 (Staatscourant nr. 69458).

Management of the programmes in the assessment cluster WO Scheikunde convened to discuss the composition of the assessment panel and to draft the list of candidates.

Having conferred with management of the Bachelor Chemical Science and Engineering programme of University of Twente, Certiked invited candidate panel members to sit on the assessment panel. The panel members agreed to do so. The panel composition was as follows:

- Dr. C. Terlouw, associate professor emeritus Enrolment Management and Educational Transition, director Information Centre for Transition Issues, Saxion University of Applied Sciences (panel chair);
- Prof. dr. A.H.T. Boyen, associate professor emeritus, Faculty of Sciences and Bio-engineering Sciences, Faculty of Medicine and Pharmacy, Vrije Universiteit Brussel (panel member);
- Prof. dr. M.K. Van Bael, professor Inorganic and Physical Chemistry, head of Inorganic and Physical Chemistry Research Group, University of Hasselt (panel member);
- Prof. dr. ir. G.B. Marin, professor Chemical Reaction Engineering, head Laboratory for Chemical Technology, Ghent University (panel member);
- Drs. O. de Vreede, head Innovation and Human Capital, VNCI, Association of the Dutch Chemical Industry (panel member);
- L. Büller BSc, student Master Life Science and Technology, Delft University of Technology (student member).

On behalf of Certiked, drs. W. Vercooteren served as the process coordinator and secretary in the assessment process.

All panel members and the secretary confirmed in writing being impartial with regard to the programme to be assessed and observing the rules of confidentiality. Having obtained the authorisation by the University, Certiked requested the approval of NVAO of the proposed panel to conduct the assessment. NVAO have given their approval.

To prepare the assessment process, the process coordinator convened with management of the programme to discuss the outline of the self-assessment report, the subjects to be addressed in this report and the site visit schedule. In addition, the planning of the activities in preparation of the site visit were discussed. In the course of the process preparing for the site visit, programme management and the Certiked process coordinator regularly had contact to fine-tune the process. The activities prior to the site visit have been performed as planned. Programme management approved of the site visit schedule.

Well in advance of the site visit date, programme management sent the list of final projects of graduates of the programme of the most recent years. Acting on behalf of the assessment panel, the process coordinator selected the theses of 15 graduates from the last two years. The grade distribution in the selection was ensured to conform to the grade distribution in the list, sent by programme management.

The panel chair and the panel members were sent the self-assessment report of the programme, including appendices. In the self-assessment report, the student chapter was included. In addition, the expert panel members were forwarded a number of theses of the programme graduates, these theses being part of the selection made by the process coordinator.

Several weeks before the site visit date, the assessment panel chair and the process coordinator met to discuss the self-assessment report provided by programme management, the procedures regarding the assessment process and the site visit schedule. In this meeting, the profile of panel chairs of NVAO was discussed as well. The panel chair was informed about the competencies, listed in the profile. Documents pertaining to a number of these competencies were presented to the panel chair. The meeting between the panel chair and the process coordinator served as the briefing for panel chairs, as meant in the NVAO profile of panel chairs.

Prior to the date of the site visit, all panel members sent in their preliminary findings, based on the self-assessment report and the final projects studied, and a number of questions to be put to the programme representatives on the day of the site visit. The panel secretary summarised this information, compiling a list of questions, which served as a starting point for the discussions with the programme representatives during the site visit.

Shortly before the site visit date, the complete panel met to go over the preliminary findings concerning the quality of the programme. During this preliminary meeting, the preliminary findings of the panel members, including those about the theses were discussed. The procedures to be adopted during the site visit, including the questions to be put to the programme representatives on the basis of the list compiled, were discussed as well.

On 18 September 2018, the panel conducted the site visit on the University of Twente campus. The site visit schedule was as planned. In a number of separate sessions, the panel was given the opportunity to meet with the Faculty representatives, programme management, Board of Examiners members, lecturers and final projects examiners, and students and alumni.

In a closed session near the end of the site visit, the panel considered every one of the findings, weighed the considerations and arrived at conclusions with regard to the quality of the programme. At the end of the site visit, the panel chair presented a broad outline of the considerations and assessment conclusions to programme representatives.

Clearly separated from the process of the programme assessment, the assessment panel members and programme representatives met to conduct the development dialogue, with the objective to discuss future developments of the programme.

The assessment draft report was finalised by the secretary, having taken into account the findings and considerations of the panel. The draft report was sent to the panel members, who studied it and made a number of changes. Thereupon, the secretary edited the final report. This report was presented to programme management to be corrected for factual inaccuracies. Programme management were given two weeks to respond. Having been corrected for these factual inaccuracies, the Certiked bureau sent the report to the University Board to accompany their request for re-accreditation of this programme.

3. Programme administrative information

Name programme in CROHO: B Chemical Science and Engineering (Scheikundige Technologie)
Orientation, level programme: Academic Bachelor
Grade: BSc
Number of credits: 180 EC
Specialisations: N.A.
Location: Enschede
Mode of study: Full-time (language of instruction Dutch; from 2018/2019 English)
Registration in CROHO: 21PH-56960

Name of institution: University of Twente
Status of institution: Government-funded University
Institution's quality assurance: Approved

4. Findings, considerations and assessments per standard

4.1 Standard 1: Intended learning outcomes

The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Findings

The Bachelor Chemical Science and Engineering programme is one of the programmes offered by the Faculty of Science and Technology of University of Twente. The Faculty Board has the responsibility for the programme quality. The programme director, assisted by the programme coordinator, takes care of the day-to-day management of the programme. The Programme Committee, consisting of an equal number of lecturers and students, advises programme management on quality issues. The Board of Examiners has the authority to ensure the quality of examinations and assessments of the programme. The Programme Committee and the Board of Examiners are shared by this Bachelor programme and the Master Chemical Engineering programme. The Curriculum Committee discusses the curriculum and curriculum changes.

The programme is a three-year, research-based, broad bachelor programme in the chemistry, materials science and process technology disciplines. The objectives of the programme are to educate students in theoretical and practical terms and at basic level in the chemistry, materials science and chemical process technology disciplines, to train them in skills for research, design and organisation in these disciplines and to allow them to explore these disciplines and the discipline boundaries.

The objectives of the programme conform to the domain-specific reference framework for the chemical sciences in the Netherlands, which has been drafted by the joint programmes of this assessment cluster in the Netherlands. In this domain-specific framework, reference has been made to international frameworks and benchmark statements. This University of Twente programme may be regarded to be placed in the chemistry and chemical engineering sub-domains of the chemical sciences.

The programme aims primarily to prepare students for studies at the master level in the chemical engineering domain or in related disciplines. Students may enter the labour market for technical positions at bachelor level in the chemical engineering research, design or teaching fields. Students may also opt for the position as grade-two qualified teacher in Chemistry in Dutch secondary education. The programme endeavours to educate students either as researchers or as designers/engineers or as managers/organisers in these domains, depending upon their ambitions and talents. These positions will under normal circumstances be taken up by students, only after having completed the subsequent master programme.

The programme objectives keeps abreast of current trends in the professional field, maintaining relations with industry. Many lecturers in the programme have backgrounds in industry. The programme has contacts with spin-off companies in the Twente region. Guest lecturers from industry are involved in courses.

The programme objectives have been translated into the intended learning outcomes of the programme. The intended learning outcomes specify, among others, knowledge of relevant fields within the chemical engineering discipline, knowledge of and skills in research and design methodologies, academic skills, such as reasoning, judgemental, communication, and collaborative skills and societal and ethical awareness.

Programme management demonstrated the programme intended learning outcomes to meet a number of international frameworks in this domain, such as the European Federation of Chemical Engineering qualifications and the Eurobachelor qualifications of European Chemistry Thematic Network Association. In addition, the intended learning outcomes correspond to the Meijers' criteria, showing these to match the bachelor level.

Considerations

The panel considers the programme objectives to be sound. The panel welcomes the broadness of the programme, educating students in the disciplines of chemistry, materials science and process technology. The programme addresses very well both the molecular and technological dimensions of the chemical engineering field. This Bachelor programme and the subsequent Master Chemical Engineering allow students to be broadly educated in this field and to select one of the specialisations in the Master programme. The panel considers this bachelor-master trajectory to be a very valuable concept. The panel appreciates students being offered the opportunity to develop their skills as researchers or as designers/engineers or as managers/organisers.

The objectives of the programme are within the boundaries of the domain-specific reference framework for academic chemical sciences programmes. The panel appreciates the efforts by the joint programmes in chemical sciences in the Netherlands to draft this framework and regards this to be a sound and up-to-date description of this domain. The profile of this University of Twente programme may be clearly distinguished within the framework.

The panel understands and supports the programme position to educate students to continue their studies at master level and not so much to enter the labour market. The panel acknowledges the relevance for the programme to monitor current trends in industry. At the same time, the panel advises to formulate future trends, relevant for the programme, in more clear terms to allow the programme to adjust to these trends for a sharper positioning in the professional field.

The objectives have been well-translated into the intended learning outcomes of the programme. The panel finds the intended learning outcomes to be very clearly and explicitly formulated. The intended learning outcomes meet international frameworks and conform to the bachelor level.

Assessment of this standard

These considerations have led the assessment panel to assess standard 1, Intended learning outcomes, to be good.

4.2 Standard 2: Teaching-learning environment

The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Findings

The number of incoming students in the programme has remained rather stable, being on average about 54 students per year (figures for last five years). Programme management set the target for the yearly influx at about 70 students. This number is determined by the capacity of programme facilities. These can, however, be expanded to accommodate a larger number of students. The proportion of female students is about 20 %. The official language of instruction changed to English in September 2018, to allow international students to enrol. In effect, 25 % of the student intake are international students in this year.

The curriculum has a study load of 180 EC and takes three years to complete. Programme management presented a table, mapping the intended learning outcomes to the curriculum components. The curriculum has been organised in line with the Twente Educational Model structure, which applies to all bachelor programmes of the university. The curriculum is composed of 12 modules of 15 EC each. Specific themes are addressed in these modules. In each of the modules in the first two years, the courses are arranged around the module project. Students learn the knowledge and skills required and may apply these in the project of the module. This way, theory and practice are combined and courses' coherence is promoted within the modules. Lecturers in modules meet to adjust the courses and to ensure the coherence of modules. In the curriculum, four teaching-learning trajectories may be discerned, being materials science, chemistry and physics, process technology and mathematics and modelling. These trajectories and the courses related to them ensure the curriculum to meet the intended learning outcomes. In the last module of the second year, students may select either the materials science or the process design module. The first two modules in the third year provide students with the options to select minors to prepare for specific master programmes, to broaden their knowledge and skills on subjects different from chemical engineering, to study abroad at one of the partners universities or to acquire the grade-two teaching qualification in Chemistry. Academic and professional skills, including experimental, research, design, organisation and communication skills are addressed in most, if not all of the modules. A detailed overview of the curriculum in this respect has been drafted by programme management. Ethical problems and safety issues are covered as well. New trends, such as digitalisation are considered by programme management. The Bachelor assignment (15 EC) is the final component of the curriculum, requiring students to do an individual research project. In the curriculum, the researcher's and designer's roles are explicitly addressed, but the organiser's role more implicitly in the participation in and management of the project in the modules. Students are strongly encouraged to spend part of the programme abroad.

About 42 researchers in the chemical engineering field are involved in the programme as lecturers. In addition, about 13 lecturers coming from other Faculties or departments take part in the programme. Lecturers are active researchers, doing research within one of the chemical engineering research groups. All of the chemical engineering lecturers and the vast majority of the other lecturers have a PhD degree. The proportion of lecturers being BKO-certified is about 65 % including exemptions, whereas another 21

% of the lecturers are in the process of obtaining this certificate. In addition to this permanent staff, PhD students supervise tutorials and Bachelor assignments. Part-time and guest lecturers from industry are involved in the courses. Students' academic and professional skills are trained by an expert in this field. In the student chapter and in the meeting with the panel, students stated to greatly appreciate the knowledge and the teaching qualities of the lecturers.

Applicants with the Dutch pre-university secondary school diploma in the natural sciences & technology subject cluster or in the natural sciences & health subject cluster with mathematics B and physics are unconditionally admitted to the programme. Students with other subject clusters are admitted, if they have taken mathematics B, physics and chemistry. Students coming from abroad, have to meet comparable requirements. If their prior education does not meet these criteria, they are referred to the foundation year. Before entering, applicants complete the study-choice check activities. These include questionnaires to be filled out and individual interviews by programme staff. The study-choice activities result in non-binding advice by programme management either to enter the programme or to refrain from entering.

The programme educational concept is the Twente Educational Model project-led education. Students apply the knowledge acquired and the skills gained in the courses of the modules in the module projects, integrating theory and practical application. The average number of hours of face-to-face education in the curriculum is about 20 hours per week in the first year and about 17 hours per week in the second year. In the third year, the number depends upon the minor taken. The study methods are selected in line with the educational concept and include lectures, tutorials, lab courses, projects, excursions and guided self-study. In most courses, two lecturers are involved. In the first year, students are guided by their individual mentor, being a staff member. The mentor's role becomes less prominent in the second and third year. The study advisor is available for students in case of study problems. Student mentors will assist international students. The overall students-to-staff ratio is 20: 1. In the first year, students have to attain 45 EC. If they do not succeed, they have to leave the programme. About 30 % of the students leave the programme during the first year, among them a small group have to stop due to the binding recommendation (BSA). After the first year, practically all students stay in the programme. The student success rates after three years are on average about 52 % and after four years they are on average 79 % (figures for last two to three cohorts, proportions of students re-enrolling in second year). The last few years, the student success rates improved significantly.

Considerations

The panel regards the number of incoming students adequate, being within programme capacity limits, but understands programme management's intentions to raise this number to about 70 students per year.

The curriculum matches the intended learning outcomes of the programme. The panel appreciates the contents of the curriculum, especially the transformation to Twente Educational Model-modules, noting the courses to be solid in terms of contents. The panel regards the curriculum to be research-based and to be up-to-date, new trends being incorporated. The curriculum is coherent, the Twente Educational Model structure being welcomed by the panel. The panel is positive about the academic and professional (soft) skills being addressed. The panel encourages the further systematic development and assessment of the teaching-learning trajectory of these skills. The panel proposes to adapt the mathematics courses more to this specific programme contents.

The lecturers in the programme are well-reputed researchers and skilled teachers. Their educational capabilities are regarded by the panel to be up to standard. Student advice and counselling are well-organized and are appreciated by the students. The panel considers the team of lecturers, study advisor, and mentors to be very motivated and enthusiastic. The panel perceived strong alliance in views on the programme between programme management and the before-mentioned team. The panel notes the capacities of the lecturers to be very much appreciated by students.

The entry requirements and admission procedures of the programme are appropriate.

The panel appreciates the educational concept and the study methods of the programme, as these promote students to actively engage in the learning processes. The panel finds the number of lab courses adequate. The students-to-staff ratio and the number of hours of face-to-face education in the programme meet the standards. The study guidance by mentors and the study advisor is up to standard. Although the programme is challenging, the panel considers the programme to be feasible and the study load to be evenly distributed. The student success rates are appropriate.

Assessment of this standard

These considerations have led the assessment panel to assess standard 2, Teaching-learning environment, to be good.

4.3 Standard 3: Student assessment

The programme has an adequate system of student assessment in place.

Findings

The examinations and assessments in the programme are governed by the programme framework in this respect and the Education and Examination Regulations, both of these complying with University of Twente guidelines. As has been indicated, the Board of Examiners has the authority to ensure the quality of examinations and assessments of the programme. The Board works along rules, which meet University of Twente guidelines. One of the members of the Board is an external member.

The examination methods in the courses are written examinations, written assignments, lab assignments and lab reports, written reports and oral presentations. Most courses are assessed by means of more than one examination method. Academic skills' assessments, such as writing skills, are included in the course assessments. In case of group work, individual performances by students are assessed by means of oral assessments. Peer review among students has been adopted, but not in all courses.

The Bachelor assignment is an individual research project. Before starting the assignment, students must complete the literature study and draft the set-up. The report and presentation of these are assessed in terms of a go/no-go judgement. Students are presented topics by research groups. During the assignment, students do their work at one of the research groups. Day-to-day supervisors may be PhD students, acting under the responsibility of supervisors. At completion of their Bachelor assignment, students are to submit the written report and are to present and defend the results. The assignment is assessed by the Bachelor assignment committee, being composed of at least three members and including at least one (deputy) member of the Board of Examiners coming from another research group. They use a scoring form for their assessment, which includes research process, contents, research skills, report design and presentation as assessment criteria.

In the programme, measures have been taken to ensure the validity, reliability and transparency of examinations and assessments. The principle of constructive alignment has been adopted, aligning the learning goals, study methods and examination methods in the courses. The Board of Examiners appoints the examiners. Examination drafts are to be peer-reviewed by fellow examiners. Examinations include test matrices. Examination results across modules are discussed among examiners, Board of Examiners members being present. In case of deviant grade distributions, examinations are analysed and discussed.

Considerations

The panel considers the examination and assessment policies for the programme to be appropriate, these being in line with the University of Twente guidelines. The position and authority of the programme Board of Examiners are adequate. The panel regards the Board as being very serious and very professional in executing their duties.

The panel approves of the examination methods adopted in the programme, noting these to be consistent with the goals and the contents of the courses. The panel supports programme management's intentions to prevent free-riding in group projects and assignments. The panel is pleased to see academic and professional (soft) skills being assessed and encourages programme management to assess these more systematically in the framework of a teaching-learning trajectory through the curriculum.

The supervision and assessment processes for the Bachelor assignments are well-organised. Students are offered appropriate supervision. The assessment procedures are up to standard, the assignment committee involving at least three examiners and being conducted using scoring forms with relevant criteria.

The measures taken to ensure the validity, reliability and transparency of examinations and assessments are adequate. The panel suggests to strengthen the peer review of examinations.

Assessment of this standard

The considerations have led the assessment panel to assess standard 3, Student assessment, to be satisfactory.

4.4 Standard 4: Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.
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Findings

The panel studied the examinations of a number of courses of the programme.

The panel also reviewed the Bachelor assignments of fifteen graduates of the programme with different grades. In the assignments, students have to demonstrate to be able to conduct an individual research project within the domain of the programme. The average grade of the Bachelor assignments of the last three years is 7.7.

As has been indicated, programme graduates may enter master programmes in chemical engineering or related fields. The vast majority of the graduates (about 90 %) continue their studies in the Master Chemical Engineering programme of University of Twente. Graduates perform well in these master programmes, nearly all of them completing this programme and taking on average 2.4 years to finish these. The other graduates proceeded their studies at master programmes in related fields of University of Twente or of other universities.

Considerations

The panel regards the course examinations, which were reviewed by panel members, to be up to standard.

The panel supports the grades awarded to the Bachelor assignments by the programme examiners. The panel considers these assignments to be well-elaborated and to be solid in terms of theory and methodology.

The panel is convinced that students having completed the programme reached the intended learning outcomes and regards the graduates of this programme to be well prepared to continue their studies at master level in this domain.

Assessment of this standard

The considerations have led the assessment panel to assess standard 4, Achieved learning outcomes, to be good.

5. Overview of assessments

Standard	Assessment
Standard 1. Intended learning outcomes	Good
Standard 2: Teaching-learning environment	Good
Standard 3: Student assessment	Satisfactory
Standard 4: Achieved learning outcomes	Good
Programme	Good

6. Recommendations

In this report, a number of recommendations by the panel have been listed. For the sake of clarity, these have been brought together below.

- To formulate future trends, relevant for the programme, in more clear terms to allow the programme to adjust to these trends for a sharper positioning in the professional field.
- To adapt the mathematics courses more to the specific contents of this programme.
- To assess academic and professional skills more systematically in the framework of a teaching-learning trajectory.
- To try and prevent free-riding, in line with programme management's intentions.
- To strengthen peer review of the design of examination assignments among examiners.