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Assignment 1

Innovation of a Learning Environment

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Introduction

The National Healthcare Group-Ophthalmology Residency Program (NHG-ORP) is a 5-year program accredited by the Accreditation Committee for Graduate Medical Education-International since 2012. It is a Competency-based Medical Education System involving 6 competency domains (**Annex-1**).

Problems with the current curriculum

Its confusing multitude of competencies, assessed as individual task performances (Aschenbrener, 2015), does not translate to practice performance (Rethans et al., 2002). Stakeholders' interviews revealed that our residents had difficulties in integrating and applying different competencies, and problem-solving (unit-3 assignment findings).

Entrusted Professional Activity (EPA)-based System (EPAS) as a solution

EPA relates to clinical practice rather than individual competencies. It requires the synthesis and integration of many competencies to perform a clinical task (ten Cate et al., 2015). EPAs are units of professional tasks that a resident is permitted/entrusted to perform unsupervised after attaining competencies on assessment (ten Cate, 2005).

The Health Ministry mandated all Singapore residency programs (including NHG-ORP) to change to a EPA-based System (EPAS). EPAS aims to define and assess professional practice with more validity and pragmatism.

Using the 4 component instructional design (4C/ID) to support whole-task learning involving EPA

Competency acquisition, involving knowledge, skills and attitudes integration, is a complex learning process (Baartman & de Bruijn, 2011). A **whole-task** model supports complex learning and curricular transfer to practice (van Merriënboer & Sweller, 2010). It trains students to function in complex and variable clinical settings (Yardley et al., 2013).

4C/ID is used to design the learning environment of a whole-task-based medical educational program (Vandewaetere et al., 2014). It supports complex learning (van Merriënboer, Clark & de Croock, 2002) and problem-solving skill training (van Merriënboer, 2013). Its learning whole-tasks, requiring integration of task-specific constituent skills, resembles the professional tasks of EPAs (van Merriënboer & Kirschner, 2018).

It attains NHG-ORP educational goals of EPAS implementation, competency integration and transfer to practice. Its holistic approach (Kirschner & van Merriënboer, 2008) avoids compartmentalisation (separating a whole into atomistic learning domains), fragmentation (disintegrating a complex skill into individual sub-skills) and transfer paradox (low transfer from orderly learning sequencing).

The EPA “**Pre-operative Management of Cataract Patients in Ophthalmic Practice**” is selected because managing cataract patients is a common practice. It is a complex whole-task requiring integration and transfer of many competency domains e.g. managing cataract-induced myopia involves “patient care” (lens prescription) and “professionalism” (counselling spectacle use) domains. Its *skill clusters, constituent skills* and their inter-relationships are represented in a skill hierarchy (**Annex-2**). The skills are mapped to various competency domains (**Annex-3**).

Literature Search (**Annex-4**)

Educational Resource Information Centre search found *two* relevant non-medical papers describing the principles and applications of 4C/ID. **PubMed search** revealed 8 medical papers on curriculum design with 4C/ID. Seven papers are excluded as they do not involve work-based training e.g. presentation and research skills. Only *one* paper (Vandewaetere et al., 2015) which reports using 4C/ID to

design a whole-task-based clinical care program is included. The literature is lacking in designing EPA-based training program with 4C/ID despite many publications on EPA-based curriculum.

Ten Steps to complex learning

These are modified from 4C/ID to develop a whole-task-based course (van Merriënboer et al., 2018) like our EPA-based learning module. The module's **training blueprint (Annex-5)** illustrates how 4C/ID supports complex learning in first-year residency. The literature-based principles for various steps are described below.

Component 1: Learning Tasks (LTs)

Each *task class* (TC) contain LTs of *equivalent* complexity as determined by the number of *constituent skills* and skill elaboration/coordination involved. The complexity factors include cataract density and the types of risk factors (medical, mental and ocular [low/high risk]). Training progresses from simple-to-complex tasks (*task-class sequencing*) based on the elaboration theory (Reigeluth & Rodgers, 1980). Initially, the faculty selects LTs. Later, the residents do so to practice *task-selection skill*.

Step 1: Design learning tasks

The learning environment is the *teaching clinic* using *authentic whole-tasks* (patient management) with varying contents (cataract types and number of risk factors). This *task variability*, reflecting real-life practice, enables cognitive schema development to facilitate schema-based transfer of learning (Paas & van Merriënboer, 1994). Knowledge is induced from concrete experiences (f managing patients) i.e. **inductive learning** (Kirschner et al., 2008). LT1.1 (mild cataract without risk factor) is an *epitome*, the simplest starting whole-task (van Merriënboer, Clark & de Croock, 2002).

Support and guidance diminish with time as the learner's competence increases (*scaffolding*) in a repetitive saw-tooth pattern (**Annex-6**) for subsequent TCs (van Merriënboer et al., 2018). They are presented as faculty feedback and worked-examples (modelling examples and case studies). The residents perform the LTs under direct supervision (e.g. LT1.2-1.4), indirect supervision (LT1.5) then independently (LT1.6).

The fidelity of the task environment increases with time e.g. last LT in TC1 is a conventional case in the *regular clinic*. *Dynamic task selection* is done iteratively based on task performance to improve learning outcomes and transfer performance (Corbalan, Kester & van Merriënboer, 2008) e.g. having additional LTs and support for under-performing residents.

Step 2: Design assessment information

The *performance objectives* are pre-defined for all constituent skills of the LTs. Some parts of them become *performance standards* which define the acceptable task performances using criteria (e.g. correct examination technique), values (e.g. patient-safety regulations) and attitudes (e.g. ethical behaviour). The skills are classified (van Merriënboer et al., 2018) as non-recurrent (e.g. refining history-taking), recurrent (e.g. refraction) and recurrent-to-be automated (e.g. funduscopy).

Step 3: Sequencing learning tasks

For TC1, *whole-part sequencing* (Mulder, Lazonder, & de Jong, 2011) is used because it is very complex and requires many skills. Whole-task sequencing from simple-to-complex is done, followed by dividing whole-task into parts (skill clusters) for *part-task sequencing*. The parts are sequenced using a **backward chaining with snowballing** approach (van Merriënboer et al., 2018): the previous part(s) are included in the new part, like a rolling snowball accumulating more snow (e.g. LT1.2-1.4). This takes more time and effort but is effective in reducing task complexity that hinders integration and coordination of various parts.

For TC2 and 3, *whole-task sequencing* is utilised after the learner gains some skill competency. This is possible as every LT is whole-task practice in TC1. Using an **emphasis manipulation approach** (van

Merriënboer et al., 2018), the residents are trained to execute all constituent skills simultaneously but each LT focuses on training different skills sequentially (e.g. clinical work-up for LT2.2, counselling for LT2.3).

Component 2: Supportive Information (SI)

Step 4: Design supportive information

SI entails general, abstract information (e.g. systematic approaches to problem-solving, SAPs) which requires illustration with concrete examples to relate them experientially (van Merriënboer et al., 2018) e.g. SI1.1, approach to examining cataract patents with risk factors.

SI, provided before and/or during practice, is required for the *non-recurrent* task aspects (e.g. reasoning, decision-making). It enables deep processing and enhances *schema construction/reconstruction* through *elaboration* by relating new information (e.g. rules, goals) to prior knowledge and activating it through strategies like mobilisation and perspective taking (Wetzels, Kester & van Merriënboer, 2011). Schemas include **cognitive strategies** and **domain models**.

The presentation approach varies with the learner's experience (van Merriënboer et al., 2002): *inductive-expository* (giving examples then general information) for novices (SI1.1,1.3-1.6); *guided discovery* (using leading questions to discover relationships in general information) after TC1 (SI2.3-2.4, SI3.4-3.5); and *deductive-inquisitory* (giving general information then asking for examples) for experienced learners (SI2.5, SI3.6).

Cognitive feedback is given after each LT to make residents reflect and compare their schemas with those of experts and peers (at later stage) to identify areas for improvement. It refines/revises schemas (Balzer, Doherty & O'Connor, 1989). It is provided as *reflective prompts* (e.g. LT1.3, how one's counselling approach differs from experts), *counter-examples* (e.g. LT1.4, why one's clinical work-up cannot apply in another case) and *hypothetical cases* (e.g. LT1.5, how one's counselling approach change with a hypothetical case).

Step 5: Analyse cognitive strategies (SAPs and rules-of-thumb/heuristics)

These are identified through analysing documents and interviewing task performers. **SAPs** depict the temporal order of task-specific problem-solving phases/sub-phases to attain the goals/sub-goals e.g. SI1.3, approach in history-taking to diagnose cataract. **Rules-of-thumb/heuristics** explain how a change *causes* (e.g. eye examination detects ocular risk factors) or *predicts* an effect (e.g. managing risk factors makes surgery safer). They specify the operating condition and action(s) required for goal attainment at each phase/sub-phase. Video **modeling examples** are used to present SI e.g. SI1.4, an expert does eye examinations to detect ocular risk factors and explains the task-specific SAPs and heuristics.

Step 6: Analyse domain/ mental models

Domain models are identified from document analysis and task performers' interviews. They specify how domain elements are organised and related to each other (Kirschner et al., 2008). They can be *conceptual* (describing and classifying things/events e.g. cataract classified by its structural location), *structural* (relating things/events in time and space e.g. cataract relates to myopia then spectacles/surgery), *causal* (describing how things/events affect each other e.g. how hypertension causes surgical complications). Step 6 is omitted because these are well described in textbooks (e.g. SI1.2) and publications in Ophthalmology.

Case studies are used to illustrate domain models e.g. worked-out examples showing the presenting symptoms (given/problem state), clinical work-up steps (solution) and cataract diagnosis (goal state). The residents process the problem and solution steps deeply, and compares them with other cases to *induce* generalised solutions. **Case method** (Tärnvik, 2007), involving small group case discussions and cognitive feedback, is used e.g. LT2.1.

Component 3: Procedural Information (PI)

Step 7: Design procedural information

PI is relevant to the LT and presented *just-in-time* to allow performance of **recurrent** task aspects e.g. pupil examination. The *resident handbook* provides step-by-step instructions on the procedure/algorithm (**cognitive rules**) and **prerequisite knowledge** for correct rule application. Cognitive rules are also provided as *information displays* (e.g. LT1.2, e-prescription manual) and *demonstrations* (e.g. LT1.3, video on eye-examination steps). Prerequisite knowledge is presented as *instances* using illustrative examples of concepts/principles.

PI is activated in working memory during practice to aid **rule construction** in long-term memory through **knowledge compilation** (Kirschner et al., 2008). It **fades** with time and is replaced by new information (van Merriënboer et al., 2002) e.g. PI to manage low risk ocular factors is presented in LT2.1-2.2, fades in LT2.3 then is replaced by PI on consent-taking in LT2.4.

Timely **corrective feedback** is important PI to recognise an error, explain its cause(s) and prompt correct rule(s) application. This is initially given *unsolicited* by the faculty (e.g. LT2.2-2.4) but later *solicited* by the learner (e.g. LT2.5-2.6) to foster self-directed learning.

Step 8: Analyse cognitive rules

Experts' task performances are analysed to determine the rules for correct skill performance. Each rule describes the condition ("IF") and action ("THEN") to be taken. The analysis can be **procedural-based** (e.g. temporal sequence of examination steps) or **rule-based** (e.g. uncontrolled hypertension needs medical referral).

Step 9: Analyse prerequisite knowledge

Prerequisite knowledge (as facts/concepts/principles/plans) is mandatory for correct procedural performance/decision-making (van Merriënboer et al., 2018). It is available to the lowest-level learners in TC1 (e.g. study aid) and is part of the cognitive rule e.g. the concept of history-taking is explained followed by its performance instruction. This step is therefore **omitted**.

Component 4: Part-Task Practice (PTP)

PTP automates recurrent constituent skills that are critical/important. For patient safety, it is first done on *simulators* then *patients* in the regular clinic. After being introduced to a whole-task, the resident commences PTP to learning in a meaningful context e.g. LT1.1, simulator-based learning of examination skills starts after studying worked-examples. It facilitates **rule automation** through **strengthening** (Kirschner et al., 2008). The cognitive rules strengthen with repeated applications/overlearning.

PTT, inter-mixed with whole-task practice, finishes upon reaching its standard. Short PTT distributed over time (spaced-practice) is better than prolonged massed practice (Benjamin & Tullis, 2010).

Step 10: Design part-task practice

Part-task sequencing is done as many procedures and rules are involved. A **forward chaining with snowballing (A, AB, ABC) approach** is used (van Merriënboer et al., 2018): Skill-Cluster A skills are mastered followed by those of B and C. **Segmentation** sequencing which follows the temporal order of the work process in practice is utilised.

The PTP cases are initially selected by the faculty. Later, the residents are encouraged to *self-assess* and select appropriate patients to do PTT of their deficient skills, and develop **task-selection skill**. Their **independent PTT** enables skill mastery with deliberate practice (Ericsson, 2004).

Assessments for the EPA-based Learning Module (Annex-7)

Domain-specific skills

Formatively, *key feature questions* (Hrynchak, Takahashi & Nayer, 2014) and *concept maps* (Daley & Torre, 2010) are chosen to assess clinical reasoning and decision-making. *Ophthalmic Clinical Evaluation eXercise (OCEX)*, a validated 33-item workplace-based assessment tool (Golnik & Goldenhar, 2005), is heavily relied on to assess clinical competency through observing task performance (including reasoning) in our worked-based learning environment (**Annex-8**). OCEX, done after each LT, involves many assessors across different contexts (cases) to improve its reliability.

EPA bridges workplace-based assessment of abstract competencies and practice (Driessen & Scheele, 2013). *EPA* defines the professional tasks for practice entrustment. Similarly, *TC* defines the *LTs* for training progression through task competency attainment. The *entrustment level* varies with task complexity e.g. first-year residents are entrusted to perform *TC2* tasks under indirect supervision but independently for simpler *TC1* tasks.

Summatively, *vignette-based MCQ tests* (assessing knowledge and its application) and *OSCE* (assessing clinical and communication skills) are used. Using many methods balances their strengths and weaknesses, and allows comprehensive evaluation through triangulation.

Domain-general skills

This module promotes **task-selection** (by residents), **self-assessment** (during independent *PTT*) and **peer-assessment** (e.g. *LT2.1*). The last 2 skills are important for developing self-directed learning (van Merriënboer et al., 2018). They are assessed formatively by *observations* (regular) and *portfolio*. Portfolio is used formatively for *learning and development*, and summatively for *progress decision-making* by group judgement of competency attainments in domain-specific and domain-general skills.

Critical Reflection

The benefits of using the 4C/ID model in my context

Cognitive Apprenticeship, Problem-Based Learning and Goal-Based Scenario are other examples of task-based instruction. They are based on the principles of learning tasks, prior knowledge activation, demonstration/modeling, application and integration/exploration (Francom, 2017). However, they have some deficiencies. Cognitive apprenticeship focuses more on community of practice and social context for on-the-job training, but less on supportive information (Collins, Brown & Holum, 1991). Problem-Based Learning uses knowledge-orientated problems but may not improve clinical performance (Colliver, 2000). Goal-Based Scenario uses scenarios as a “learning-by-doing” simulation for learners to apply their knowledge and skills but is primarily computer-based (Schank, Fano, Bell & Jona, 1993).

In contrast, 4C/ID uses work-based, authentic whole-tasks for training and augments learning with *SI*, *PI* and *PTT*. Importantly, it explicates the instructional measures (as *SI*) for training problem-solving skill (van Merriënboer, 2013) which our residents lack.

The limitations of using the 4C/ID model in my context

The regular clinic is a learning environment with heterogeneous case-mix and heavy patient-load that renders *LT* selection and teaching difficult. To overcome this, *teaching clinics* with few *pre-selected* patients and designated faculty are implemented. The faculty enrolls patients of suitable complexity into these clinics and gives the appropriate supervision/guidance (scaffolding) during/after *LT* performance.

Patient safety and care standards are paramount. To optimise patient care and learning, *part-task practice with simulators* (e.g. fundoscopy) before practising on patients and timely support with *job aids* (e.g. e-manuals) and *study guides* (e.g. resident handbook) are crucial, besides faculty supervision.

The faculty, unfamiliar with the complex 4C/ID concepts (e.g. cognitive feedback) and design, will require training through course/workshops and supervised practice (peer coaching) to optimise teaching.

Innovativeness of my design

It is novel to use 4C/ID in Ophthalmology and combine two approaches: *backward chaining with snowballing* for whole-part sequencing, and *forward chaining with snowballing* for part-task sequencing. This combination reduces the learning cognitive load and facilitates competency attainment in all constituent skills sequentially. The 4C/ID, based on cognitive research and theory, holistically addresses many aspects of complex learning.

Conclusion

The ten steps, modified from the 4C/ID model, supports the complex learning of professional whole-tasks/EPAs in Ophthalmology. Its holistic approach, based on literature-based learning principles, enables NHG-ORP educational goals of EPAS implementation, competency integration and transfer to be achieved.

(Total word count: 2488 (excluding all headings); 2628 words, (including all headings))

Annex 1. The 6 Accreditation Committee for Graduate Medical Education-International (ACGME-I) Competency Domains used in National Healthcare Group-Ophthalmology Residency Program. (For reference only).

The six Accreditation Council for Graduate Medical Education (ACGME) Core Competencies (Education Commission for Foreign Medical Graduates. 2012) are as follow:

1. Patient Care (PK)

The ability for residents to provide appropriate, effective and compassionate patient care in treating health problems and promoting health.

2. Medical Knowledge (MK)

The ability for residents to show knowledge about established and evolving clinical, biomedical and cognate (e.g. social-behavioral and epidemiological) sciences, and to apply this knowledge to patient care.

3. Practice-Based Learning and Improvement (PBLI)

The ability for residents to appraise and synthesize scientific evidence, and to investigate, evaluate and improve their patient care practices.

4. Interpersonal and Communication Skills (ICS)

The ability for residents to demonstrate communication and interpersonal skills that enable effective exchange of information and teaming with professional associates, patients and their families.

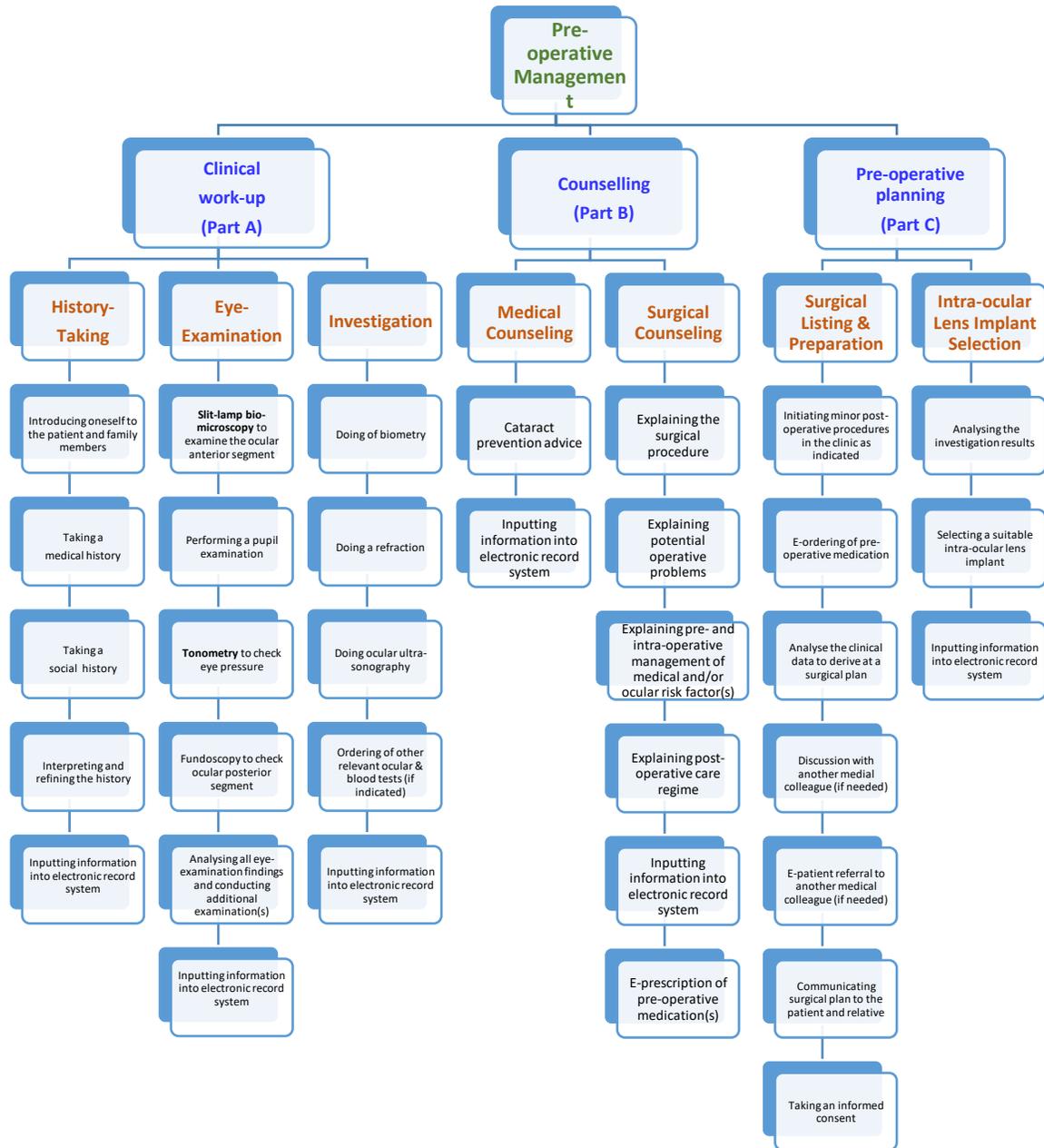
5. Professionalism (P)

The ability for residents to show a commitment to fulfilling professional responsibilities, abidance to ethical principles, and sensitivity to a diverse patient group.

6. Systems-Based Practice (SBP)

The ability for residents to be aware of and be responsive to the health care system and the larger context, and to effectively use system resources to provide optimal care.

Annex 2. A skill hierarchy to show the 3 skill clusters and their respective constituent skills for the EPA “Pre-operative Management of Cataract Patients in Ophthalmic Practice”.



Note:

1. The EPA is a complex task that involves 3 **skill clusters** (SCs) named as **parts A, B and C**. Each cluster (part) has groups of **constituent skills** with its respective performance criteria. The 3 SCs add together to form the whole-task.
2. The **skill hierarchy** shows all the constituent skill involved in the whole-task as **vertical** (pre-requisite) and **horizontal** (temporal) relations. The former means the skill above leads to the one below. The latter means the skill performance sequence occurs from left to right e.g. “eye examination” occurs after “history-taking” in a the pre-operative patient with cataract.

Annex 3. Outline of the 3 skill clusters and their respective constituent skills for the EPA “Pre-operative Management of Cataract Patients in Ophthalmic Practice”. (The ACGME-I competency domains related to the respective constituent skills are in bracket.)

ACGME-I Competency Domains: PC (Patient Care), MK (Medical Knowledge), ICS (Inter-personal Communication Skills), P (Professionalism), PBLI (Practice-Based Learning and Improvement), SBP (Systems-Based Practice).

	Constituent Skills	Performance Criteria
Clinical Work-up (Skill Cluster-A, SC-A)	History-Taking (PC, MK, ICS, P)	Introducing oneself to the patient & family members and establish rapport with them.
		Taking a medical history (symptoms, illnesses, past surgery & drug allergy) with a framework
		Taking a social history to evaluate disease impact on lifestyle and work with a framework.
		Interpreting and refining the history through asking relevant questions.
		Inputting clinical information into the electronic medical record system (EMRS).
	Eye-Examination (PC, MK, P)	Slit-lamp bio-microscopy to examine the ocular anterior segment and detect the relevant clinical signs for diagnosis.
		Performing a pupil examination and detect significant signs of co-existing eye pathology.
		Tonometry to check the eye pressure.
		Fundoscopy to examine the ocular posterior segment.
		Analysing all eye-examination findings and conducting additional examination(s) e.g. neck examination as indicated.
		Inputting clinical information into EMRS..
	Investigation (PC, MK, PBLI)	Doing a biometry to measure intra-ocular lens implant power accurately.
		Doing a refraction to determine the refractive status of both eyes accurately.
		Doing ocular ultrasonography to check ocular posterior segment (if needed with ocular media opacity e.g. dense cataract, vitreous opacities).
		Ordering of other relevant ocular and blood tests (if indicated). Example: optical coherent tomography, corneal pachymetry and specular microscopy in diabetic eye disease.
Inputting clinical information into EMRS.		

Counselling (Skill Cluster-B, SC-B)	Medical Counselling (PC, MK, PBLI, ICS, P)	Medical Counselling: explaining the medical condition(s), advising on preventive measures e.g. sunglasses, stop smoking, and diabetes control for the eye(s) not requiring surgery.
		Inputting clinical information into EMRS.
	Surgical Counselling (PC, MK, PBLI, ICS, P)	Explaining the surgical procedure to the patient/ relative in an understandable language.
		Explaining the potential operative problems of uncomplicated cataract surgery to the patient/ relative in an understandable language.
		<i>Explaining the pre- and intra-operative management</i> of medical and/or ocular risk factor(s).
		Explaining the post-operative care regime in an understandable language.
		Inputting clinical information into EMRS. E-prescription of pre-operative medication on EMRS.
Pre-operative Planning (Skill Cluster-C, SC-C)	Surgical Listing and Preparation • for cataract surgery patients (PC, MK, ICS, P, PBLI, SBP)	<i>Analyse the clinical data</i> to derive at an individualised, feasible surgical plan.
		<i>Discussion with medial colleague</i> (if needed) to manage medical and/or ocular risk factor(s).
		E-patient referral on EMRS to another medical discipline (if needed).
		<i>Communicating the surgical plan</i> to the patient or the family members or legally appointed representative (of mentally incapacitated patients).
		Informed consent-taking from the patient or the family members or legally appointed representative (of mentally incapacitated patients).
		Inputting clinical information into EMRS.
	Intra-ocular Lens Implant Selection • for cataract surgery patients (PC, MK, PBLI)	<i>Analysing the investigation results</i> e.g. biometry and ultra-sonography
		<i>Selecting a suitable intra-ocular lens implant.</i> This include the type and dioptric power to achieve the target refraction.. Inputting clinical information into EMRS.

Legend:

- **Recurrent** constituent skills **in bold blue requires automation** i.e. part-task practice required. **Recurrent** skills not requiring automation in green. Non-recurrent skills *in italic*. Some e.g. pupil examination has *cognitive* components (e.g. interpreting clinical signs) that is not recurrent, although the psychomotor component (examination steps) may be recurrent (i.e. same steps used for all examinations).

Annex 4. Literature search based on the research question (relevant papers highlighted in bold blue).

The **PICO Method** is used:

- **Population:** Ophthalmology Residents
- **Intervention:** Four-component Instructional Design (4C/ID)
- **Comparison:** None because the research question is about an issue of interest.
- **Outcome:** Entrustable Professional Activity (EPA)

My research question (RQ):	How to use the Four-Component Instructional Design (4C/ID) in Ophthalmology Residents for training that involves Entrustable Professional Activities (EPAs)?			
List of sources/databases searched	Keywords/ Search terms (include search questions)	Search Strategy used, inclusion and exclusion criteria/ limits (e.g. language, date ranges of publications, types of publications)	Total number of results	Comments (include strategy used to finalise results)
ERIC (Educational Resource Information Centre) https://eric.ed.gov/	(4C/ID OR 4-component? OR four-component?) AND (Ophthalmology)	Search Strategy: <i>Boolean operator</i> “AND”, “OR”; <i>wildcard</i> (?). Limits: 2001-2020, peer-reviewed only No limit on author, publication type and educational level.	0	
ERIC https://eric.ed.gov/	(4C/ID OR 4-component? OR four-component?) AND (resident? OR residency)	Search Strategy: <i>Boolean operator</i> “AND”, “OR”; <i>wildcard</i> (?). Limits: 2001-2020, peer-reviewed only No limit on author, publication type and educational level.	2	None of them are relevant to the RQ.
ERIC https://eric.ed.gov/	(EPA? OR entrustable professional activit*) AND (Ophthalmology)	Search Strategy: <i>Boolean operator</i> “AND”; <i>phrase searching</i> ; <i>truncation</i> (*), <i>wildcard</i> (?). Limits: 2001-2020, peer-reviewed only No limit on author, publication type and educational level.	7	None of them are relevant to the RQ.

<p>ERIC https://eric.ed.gov/</p>	<p>(EPA? OR entrustable professional activit*) AND (resident? OR residency)</p>	<p>Search Strategy: <i>Boolean operator “AND”; phrase searching; truncation (*), wildcard (?)</i>. Limits: 2001-2020, peer-reviewed only, publication type “journal articles”, descriptor “graduate students” and “medical education”. No limit on author and publication type.</p>	9	None of them are relevant to the RQ.
<p>ERIC https://eric.ed.gov/</p>	<p>(4C/ID OR 4-component? OR four-component?) AND (medical education)</p>	<p>Search Strategy: <i>Boolean operators “AND”, “OR”; phrase searching. wildcard (?)</i>. Limits: 2001-2020, peer-reviewed only, higher educational level, descriptor “teaching methods”. No limit on author and publication type.</p>	39	None of them are relevant to the RQ.
<p>ERIC https://eric.ed.gov/</p>	<p>(4C/ID OR 4-component? OR four-component?) AND (medical education)</p>	<p>Search Strategy: <i>Boolean operators “AND”, “OR”; phrase searching. wildcard (?)</i>. Limits: 2001-2020, peer-reviewed only, higher educational level, descriptor “models”. No limit on author and publication type.</p>	55	Only 1 paper on “Perspectives on Problem Solving and Instruction” has some relevance. This paper reports using 4C/ID to teach problem-solving skills which is lacking in the residents (unit-3 assignment findings).
<p>ERIC https://eric.ed.gov/</p>	<p>(4-component? OR four-component?) AND (instructional design?)</p>	<p>Search Strategy: <i>Boolean operators “AND”, “OR”; phrase searching; wildcard (?)</i>. Limits: 2001-2020, peer-reviewed only, higher educational level, descriptor “teaching methods”. No limit on author and publication type.</p>	55	None of them are relevant to the RQ.
<p>ERIC https://eric.ed.gov/</p>	<p>(4-component? OR four-component?) AND (instructional design?)</p>	<p>Search Strategy: <i>Boolean operators “AND”, “OR”; phrase searching; wildcard (?)</i>. Limits: 2001-2020, peer-reviewed only, higher educational level, descriptor “models”. No limit on author and publication type.</p>	47	2 papers of some relevance to RQ: 1. “Blueprints for Complex Learning: The 4C/ID-Model” . This gives an <i>overview</i> of using 4C/ID to teach complex skills.

				2. “Perspectives on Problem Solving and Instruction” . This has been found from another search strategy. The other papers are not related to the subject matter e.g. one paper on using 4C/ID to teach programming skills.
ERIC https://eric.ed.gov/	(4C/ID OR 4-component? OR four-component?) AND (entrustable professional activit*)	Search Strategy: <i>Boolean operators</i> “AND”, “OR”; <i>phrase searching; truncation (*)</i> ; <i>wildcard (?)</i> . Limits: 2001-2020, peer-reviewed only, descriptor “teaching method” . No limit on author, publication type and educational level.	10	None of them are relevant to the RQ.
ERIC https://eric.ed.gov/	(4C/ID OR 4-component? OR four-component?) AND (entrustable professional activit*)	Search Strategy: <i>Boolean operators</i> “AND”, “OR”; <i>phrase searching; truncation (*)</i> ; <i>wildcard (?)</i> . Limits: 2001-2020, peer-reviewed only, descriptor “teaching method” . No limit on author, publication type and educational level	15	None of them are relevant to the RQ.
PubMed http://www.ncbi.nlm.nih.gov/pubmed	(4C/ID OR 4-component? OR four-component?) AND (ophthalmology)	Search Strategy: <i>Boolean operators</i> “AND”, “OR”; <i>phrase searching, wildcard (?)</i> . No limit. All fields included.	6	1 paper on using uses 4C/ID for case presentation curriculum which is not relevant.
PubMed http://www.ncbi.nlm.nih.gov/pubmed	(4C/ID OR 4-component? OR four-component?) AND (resident? OR residency)	Search Strategy: <i>Boolean operators</i> “AND”, “OR”; <i>phrase searching, wildcard (?)</i> . No limit. All fields included.	16	None of them are relevant to the RQ. I medical paper on using 4C/ID for simulator-based surgical skills training is excluded as it does not involve work-based learning.

<p>PubMed http://www.ncbi.nlm.nih.gov/pubmed</p>	<p>(4C/ID OR 4-component? OR four-component?) AND (entrustable professional activit*)</p>	<p>Search Strategy: <i>Boolean operators</i> “AND”, “OR”; <i>phrase searching; truncation</i> (*); <i>wildcard</i> (?). No limit. All fields included.</p>	<p>1</p>	<p>I medical paper on using 4C/ID to develop a case presentation curriculum. It is excluded as it does not involve work-based learning.</p>
<p>PubMed http://www.ncbi.nlm.nih.gov/pubmed</p>	<p>(4C/ID OR 4-component? OR four-component?) AND (medical education)</p>	<p>Search Strategy: <i>Boolean operators</i> “AND”, “OR”; <i>phrase searching; wildcard</i> (?). No limit. All fields included.</p>	<p>27</p>	<p><u>Only one</u> relevant paper that reported using 4C/ID to design a work-based training curriculum like our context: “4C/ID in medical education: How to design an educational program based on whole-task learning: AMEE Guide No. 93”. 7 medical papers reported using 4C/ID for curriculum design and included: case presentation curriculum (1), evidence-based medicine (1), Endodontics (2), communication skill (1), qualitative research skill (1), nephrostomy simulation training (1). They are excluded because they do not pertain to work-based training curriculum.</p>
<p>PubMed http://www.ncbi.nlm.nih.gov/pubmed</p>	<p>(4C/ID OR (4-component? OR four-component?) AND (instructional design)</p>	<p>Search Strategy: <i>Boolean operators</i> “AND”, “OR”; <i>phrase searching; wildcard</i> (?). No limit. All fields included.</p>	<p>11</p>	<p>10 medical papers on 4C/ID, only one relevant paper as found above (...AMEE Guide No. 93). The other papers that were excluded are 2 review papers (on integrated practice and clinical reasoning), and 7 medical papers found in the search strategy above this row.</p>

Annex 5. Training Blueprint for EPA-based Learning Module.

Residency Year 1 EPA: “Pre-operative Management of Cataract Patients in Ophthalmic Practice”

Task Class 1: Pre-operative management of patients with mild cataract and medical risk factor(s) only.

- Patients with mild cataract and visual problems that may/may not require surgery.
- Patients who are healthy or have 1 or more medical risk factor(s) e.g. hypertension, diabetes, gout
- Patients with no ocular risk factor.
- Patients with no mental risk factors e.g. dementia, neurosis, psychosis.

Supportive information 1.1:

Presentation of **mental/domain models**.

Case studies [*product-orientated* learner support (van Merriënboer et al., 2002)]

Instructional video. Available on the Eye Electronic Learning Centre, a e-learning resource centre.

- **Small group case discussion** [**case method** (Tärnvik, 2007)].
 - Being “*product-orientated*” means the 3 elements of problem-solving: *given state* (pre-operative management), *goal state* (post-operative management), and the *solutions* (clinical management plan e.g. surgery) are presented.
 - This video uses *worked-out examples* to show the **pre-operative management** (clinical work-up, counselling and pre-operative planning) of **3 patients** with different types of cataract and medical risk factors.
 - **Case 1**, age-related cataract and hypertension; **case 2**, traumatic cataract and diabetes and gout; **case 3**, drug-induced cataract with hypertension, hyperlipidemia and ischemic heart disease.

Inductive-expository approach

- After showing the video case illustrations, the faculty presents the 3 types of domain models through *case discussions* using **concept maps**:
 - **Conceptual models:** e.g. knowledge on cataract severity affecting the management plan.
 - **Structural models:** e.g. linking eye symptoms to a cataract type and a management plan.
 - **Causal models:** e.g. how one type of cataract produces its characteristic eye symptoms.

Supportive information 1.2:

Presentation of **mental/ domain models**.

Text book (*Practical Ophthalmology: A Manual for Beginning Resident*),

7th Edition, American Academy of Ophthalmology (2017), Chapter 9 on “Lens”.

- The conceptual, structural and causal mental models (as above) are presented in a written format.
- This reinforces the learnings from the case discussions. The students are instructed beforehand to compare what they have learned from the case studies with the text book information.
- It serves as a learning resource that provides supportive information *throughout* the task class i.e. the resident can refer to it to obtain information when the need arises.

Supportive information 1.3:

Presentation of **cognitive strategies**.

Modeling examples [*process-orientated* learner support].

Instructional video. Available on the Eye Electronic Learning Centre.

- Topic: **History-taking in patients with cataract-induced visual symptoms**
 - Being “*process-orientated*” means the 4 elements of problem-solving are presented: the *given state* (e.g. presenting eye symptoms), *goal state* (e.g. diagnosing the medical and eye condition), *solution and/or intermediate solution*

(e.g. medical and social history-taking procedure) and **problem-solving process** (e.g. symptom-based approach to diagnosing a cataract and medical risk factor).

- Experts *perform the constituent skills* in **history-taking** on 3 patients with different cataracts without and without medical risk factors.
- **Case 1**, nuclear cataract only; **case 2**, cortical cataract and hypertension; **case 3**, cortical and posterior sub-capsular cataracts and diabetes; case 4 has nuclear and anterior sub-capsular cataracts, gout and heart disease.

Inductive-expository approach

- The **video modeling examples** are followed by **experts' explanations** on the **systemic approaches to problem-solving (SAPs)** and **rules-of-thumb** involved in *history-taking*.
 - **SAPs** are the *problem-solving processes* e.g. symptom-based approach to diagnose a cataract type
 - **rules-of-thumb** are the *operating conditions* and *necessary actions* to complete each problem-solving phase/ sub-phases e.g. taking a driving history to assess the impact of cataract on a taxi driver.

Supportive information 1.4:

Presentation of **cognitive strategies**

Modeling examples [*process-orientated* learner support].

Instructional video. Available on the Eye Electronic Learning Centre.

- Topic: **Doing eye examinations and investigations in eye clinic patients with cataract**

- Four expert *performs the constituent skills* in **eye examination** and **ordering investigations** on the same 4 patients (as above).
- The eye examinations include slit-lamp bio-microscopy, pupil examination, tonometry, gonioscopy and funduscopy. The investigations include blood tests, biometry and ocular ultrasonography.
- The various components of doing **eye examination** (e.g. funduscopy) and **ordering investigations** (e.g. biometry, blood tests) are explained.

Inductive-expository approach

- The **video modeling examples** are followed by **experts' explanations** on the **SAPs** and **rules-of-thumb** involved.
- Experts explain the *problem-solving steps* in each examination, explicates the *clinical signs* to detect, and what *investigations* will be required depending on the clinical findings (history-taking and eye examination).

Supportive information 1.5:

Presentation of **cognitive strategies**

Modelling examples [*process-orientated* learner support].

Instructional video. Available on the Eye Electronic Learning Centre.

- Topic: **Counselling patients with cataract and medical diseases.**

- Experts *perform the constituent skills* in **counselling** on the **3 patients**.
- **Case 1**, mild cortical cataract case with hypertension not for surgery; **Case 2**, mild nuclear cataract case with diabetes and hypertension for surgery; **Case 3**, mild cortical and post sub-capsular cataracts case with hyperlipidemia and gout for surgery.
- The various components of **medical counselling** (for case 1 e.g. advice on protective eye wear) and **surgical counselling** (for cases 2 and 3 e.g. advising on cataract surgery and its post-operative care regime) are explained.

Inductive-expository approach

- The **video modeling examples** are followed by **experts' explanations** on the **SAPs** and **rules-of-thumb** involved.
- Experts explain the *problem-solving steps* in the counselling process and the *rationale* for each step.

<p>Problem-based knowledge test. (Available on the Eye Electronic Learning Centre)</p> <ul style="list-style-type: none"> - Worked examples (common clinic cases) are used to assess the students' baseline knowledge, and introduce the <i>task class content</i> and <i>performance standards</i>. - Test formats include MCQs, fill-in-the-blanks and sorting choices. - Feedback on the answers (based on the expert's opinion) are given at the end of the test. 	
<p>Learning Task 1.1: <i>Case method (small group case discussion)</i> 3 worked-out examples (case studies):</p> <ol style="list-style-type: none"> 1. Patient with nuclear cataract with <u>no</u> medical condition. 2. Patient with cortical cataract and <u>2 medical risk factor</u> (hypertension and ischemic heart disease). 3. Patient with posterior sub-capsular cataract and <u>3 medical risk factors</u> (diabetes mellitus, hypertension and hyperlipidemia). <p>- Goal: The student studies the examples and <i>explains why</i> the various steps in the management <i>leads to the desired goal</i> e.g. why slit-lamp bio-microscopy can diagnose a cataract.</p> <ul style="list-style-type: none"> • Cognitive feedback (<i>reflective prompts</i>). 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ E-manual on Electronic Medical Record System (EMRS) operating procedures including e-listing of surgery and e-prescription of pre-operative medication. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Workshop on the hospital electronic medical record system (EMRS) <ul style="list-style-type: none"> - Residents are taught how to <i>input clinical data</i>, do surgical listing and prescribe medication with a formative assessment on operating various EMRC functions. ▪ Computer laboratory <ul style="list-style-type: none"> - Residents <i>practice using EMRS</i> with dummy clinical data to do several recurrent tasks e.g. e-prescription, e-referral, e-listing.
<p>Supportive information 1.6: Presentation of cognitive strategies <i>Modelling examples (process-orientated learner support).</i> Instructional video. Available on the Eye Electronic Learning Centre.</p> <ul style="list-style-type: none"> ○ Topic: Pre-operative planning in patients with cataract and medical risk factors. - Experts <i>perform the constituent skills</i> in pre-operative planning on the 3 patients from supportive information 1.5. - The various components of <i>surgical listing and preparation</i> (e.g. e-referral to another specialist, consent-taking) and <i>lens implant selection</i> (e.g. analysis biometry results and selecting an implant based on target refraction) are explained. <p>Inductive-expository approach</p> <ul style="list-style-type: none"> - The <i>video modeling examples</i> are followed by <i>experts' explanations</i> on the <i>SAPs</i> and <i>rules-of-thumb</i> involved. - Experts explain the <i>problem-solving steps</i> in surgical listing and preparation, and why a particular lens implant is selected. 	

<p>Learning Task 1.2: <i>Completion Task</i> Practice on clinic patient number 1: <u>Mild</u> cataract (e.g. <u>cortical</u> cataract) with <u>2 medical risk factors</u> e.g. hypertension and diabetes mellitus) in the <i>teaching clinic</i>.</p> <ul style="list-style-type: none"> - The patient is <i>pre-selected by the faculty</i> from the regular clinic. - Goal: The resident demonstrates how to do pre-operative planning (skill cluster-C, SC-C) under direct supervision, while the skill clusters B and A are done by the faculty (C_{BA}). • Cognitive feedback (<u>reflective prompts</u>). 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Resident handbook: <ul style="list-style-type: none"> - The sections on the step-by-step instruction for pre-operative planning (<i>history-taking, eye examination</i> and doing <i>common investigations</i>). ❖ E-manual on EMRS operating procedures including e-listing of surgery and e-prescription of pre-operative medication. ❖ Instructional video on different eye examination techniques e.g. slit-lamp bio-microscopy, fundoscopy. ❖ Immediate corrective feedback by the faculty on the recurrent skills e.g. informed consent-taking. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Slit-Lamp bio-microscope simulator to practice <i>slit-lamp bio-microscopy</i> and <i>tonometry</i> (a recurrent SC-A skill). ▪ Eye-examination simulator to practise <i>fundoscopy</i> (a recurrent SC-A skill). ▪ Small group learning (peer learning) <ul style="list-style-type: none"> - they practice history-taking, pupil examination and other eye-examination techniques (recurrent SC-A skills). - the students practice on each other and give comments (peer assessment) followed by immediate <u>corrective feedback</u> from the faculty.
<p>Formative assessment (Ophthalmic Clinical Evaluation eXercise, OCEX)</p> <ul style="list-style-type: none"> - Pre-operative planning skills on 2 patients in the <i>regular clinic</i>. One patient on <i>consent-taking</i> and another on <i>lens implant selection</i>. - The cases are selected by <i>the faculty</i> in the regular clinic. 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Resident handbook*: the sections on: <ul style="list-style-type: none"> - step-by-step instruction for pre-operative planning (<i>fading</i>) - the practical steps for listing and preparing a cataract patient for surgery using EMRS. ❖ E-manual on EMRS operating procedures including e-listing of surgery and e-prescription of pre-operative medication (<i>fading</i>). ❖ Instructional video on different eye examination techniques. ❖ Immediate corrective feedback by the faculty on the recurrent skills e.g. eye examination skills. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Part-task sequencing⁺ of recurrent aspects of skill clusters (SC-A, SC-B and SC-C). - Forward chaining with snowballing (A, AB, ABC). <p>Practice of SC-A recurrent skills on <u>real patients</u> (<i>selected by the faculty</i>) in the <u>regular clinic</u>.</p> <ul style="list-style-type: none"> - The resident is supervised by the faculty to practice recurrent SC-A skills e.g. <i>history-taking, eye-examination skills</i> and <i>ocular ultra-sonography skill</i>.
<p>Learning Task 1.3: <i>Completion Task</i> Practice on clinic patient number 2: <u>Mild</u> cataract (e.g. with <u>posterior sub-capsular</u> cataract) with <u>1 medical risk factor</u> e.g. hypertension) in the <i>teaching clinic</i>.</p> <ul style="list-style-type: none"> - The patient is <i>pre-selected by the faculty</i> from the regular clinic. - Goal: The resident demonstrates how to do counselling (SC-B) and pre-operative planning (SC-C) <u>under direct supervision</u>, the clinical work-up (A) is done by the faculty (B_{CA}). • Cognitive feedback (<u>reflective prompts</u>). 	<p>Formative assessment (OCEX)</p> <ul style="list-style-type: none"> - Counselling skills on 2 patients in the <i>regular clinic</i>. One patient on <i>medical counselling</i> and another on <i>surgical counselling</i>. - The case(s) are selected by <i>the faculty</i> in the regular clinic.

<p>Learning Task 1.4 Completion Task Practice on clinic patient number 3 <u>Mild</u> cataract (e.g. with <u>posterior sub-capsular</u> cataract) with <u>3 medical risk factors</u> e.g. ischemic heart disease, hyperlipidemia and gout) in the <i>teaching clinic</i>. - The patient is <i>pre-selected by the faculty</i> from the regular clinic.</p> <p>- Goal: The resident demonstrates how to do <i>clinical work-up</i> (SC-A), <i>counselling</i> (SC-B) and <i>pre-operative planning</i> (SC-C) i.e. (ABC) <u>under direct supervision</u>.</p> <p>- Side-task: the resident comments on and discusses about performances of peers (<i>peer assessment</i>).</p> <ul style="list-style-type: none"> • Cognitive feedback (<i>questioning based on counter-examples</i>). 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Resident handbook*: the sections on: <ul style="list-style-type: none"> - the step-by-step instruction for counselling patients for cataract surgery. - the practical steps for listing and preparing a cataract patient for surgery using EMRS (<i>fading</i>). ❖ Instructional video on different eye examination techniques (<i>fading</i>). ❖ Immediate corrective feedback by the faculty on the recurrent skills being practiced e.g. slit-lamp biomicroscopy. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Part-task sequencing⁺ of recurrent aspects of skill clusters (SC-A, SC-B and SC-C). - Forward chaining with snowballing (A, AB, ABC) <p>Practice of SC-AB recurrent skills on real patients (<i>selected by the faculty</i>) in the <u>regular clinic</u>.</p> <ul style="list-style-type: none"> - The resident is supervised by the faculty to practice recurrent skills of SC-A and <u>SC-B</u> e.g. <i>counselling skill</i> (using a standardised form) for cataract surgery.
<p>Formative assessment (OCEX)</p> <ul style="list-style-type: none"> - Clinical work-up skills on 2 patients in the <i>regular clinic</i>. One patient on <i>history-taking</i> and another on <i>eye examination</i>. - The cases are selected <i>by the faculty</i> in the regular clinic. 	<p>Procedural information:</p> <ul style="list-style-type: none"> - Resident handbook*: the sections on: <ul style="list-style-type: none"> - the step-by-step instruction for counselling patients for cataract surgery (<i>fading</i>). ❖ Immediate corrective feedback by the faculty on the recurrent skills being practiced e.g. eye ultra-sonography. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Part-task sequencing⁺ of recurrent aspects of skill clusters (SC-A, SC-B and SC-C). - Forward chaining with snowballing (A, AB, ABC). <p>Practice of SC-ABC recurrent skills on <u>real patients</u> (<i>selected by the faculty</i>) in the <u>regular clinic</u>.</p> <ul style="list-style-type: none"> - The resident is supervised by the faculty to practice recurrent skills of SC-A, SC-B and <u>SC-C</u> e.g. <i>referral to another medical discipline</i> and <i>communication skills</i> to convey the surgical plan.
<p>Learning Task 1.5: Practice on clinic patient number 4 <u>Mild</u> cataract (e.g. with <u>nuclear and cortical</u> cataract) and <u>2 medical risk factors</u> e.g. gout and hypertension) in the <i>teaching clinic</i>. - The patient is <i>pre-selected by the faculty</i> from the regular clinic.</p> <p>- Goal: The resident demonstrates how to do <i>clinical work-up</i> (SC-A), <i>counselling</i> (SC-B), <i>pre-operative planning</i> (SC-C) i.e. (ABC) <u>under indirect supervision</u>.</p> <p>- Side-task: the resident comments on and discusses about performances of peers (<i>peer assessment</i>).</p> <ul style="list-style-type: none"> • Cognitive feedback (<i>Questioning based on hypothetical cases</i>). 	<p>Procedural information:</p> <ul style="list-style-type: none"> - Resident handbook*: the sections on: <ul style="list-style-type: none"> - the step-by-step instruction for counselling patients for cataract surgery (<i>fading</i>). ❖ Immediate corrective feedback by the faculty on the recurrent skills being practiced e.g. eye ultra-sonography. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Part-task sequencing⁺ of recurrent aspects of skill clusters (SC-A, SC-B and SC-C). - Forward chaining with snowballing (A, AB, ABC). <p>Practice of SC-ABC recurrent skills on <u>real patients</u> (<i>selected by the faculty</i>) in the <u>regular clinic</u>.</p> <ul style="list-style-type: none"> - The resident is supervised by the faculty to practice recurrent skills of SC-A, SC-B and <u>SC-C</u> e.g. <i>referral to another medical discipline</i> and <i>communication skills</i> to convey the surgical plan.

<p>Learning Task 1.6 Conventional task Practice on a clinic patient of task class complexity 1 in the regular clinic.</p> <ul style="list-style-type: none"> - The patient is <i>pre-selected</i> by the faculty from the regular clinic. - Goal: The resident demonstrates how to do all 3 skill clusters (SC-A, -B, -C) i.e. (ABC) <u>independently</u>. - Side-task: the resident discusses on the topic “optimising medical risk factors for safe cataract surgery” (given beforehand by the faculty). • Cognitive feedback# (questioning based on <u>counter-examples</u>). 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Immediate corrective feedback by the faculty on the recurrent skills being practiced. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Independent part-task practice - The <i>resident selects</i> suitable patients to practice the recurrent skills that are <i>self-assessed</i> to be deficient in the regular clinic. - The faculty gives corrective feedback when the resident requires it.
<p>Formative assessment (OCEX)</p> <ul style="list-style-type: none"> - Managing a cataract patient (using 3 skill clusters) with task class 1 complexity in the regular clinic. - The case(s) are selected <i>by the faculty</i>. 	
<p>40-item vignette-based MCQ test. (Available on the Eye Electronic Learning Centre)</p> <ul style="list-style-type: none"> - Formative assessment with a with answers and explanation. - The questions are derived from real-life clinical case scenarios to test the <i>understanding</i> and <i>application</i> of knowledge in various constituent skills. 	

Task Class 2: Pre-operative management of patients with moderate cataract, medical risk factor(s) and low risk ocular factor(s).

- Patients with moderate cataract and significant visual compromise requiring cataract surgery.
- Patient has medical risk factor(s) e.g. hypertension, diabetes, hyperlipidemia, ischemic heart disease.
- Patient has low risk ocular factor(s) e.g. high myopia, hyperopia, shallow anterior chamber, post-vitrectomy, mild diabetic retinopathy, controlled glaucoma.
- Patient has no mental risk factors e.g. dementia, neurosis, psychosis.

Supportive information 2.1:

Presentation of **mental/domain models**

Case studies [*product-orientated* learner support]

Instructional video. Available on the Eye Electronic Learning Centre.

- **Topic: Pearls and pitfalls in the pre-operative work-up of patients with complicated cataracts, medical and ocular risk factors** using case studies from the eye clinic.
 - This video uses *worked-out examples* to show the **pre-operative management** (clinical work-up, counselling and pre-operative planning) of 4 patients with different types of cataract, medical risk factors and low risk ocular factors.
 - **Case 1:** 2 medical risk factors (uncontrolled hypertension and diabetes) and 1 low risk ocular (hyperopia) factors.
 - **Case 2:** 1 medical risk factor (ischemic heart disease) and 2 low risk ocular factors (myopia and controlled glaucoma) factors.
 - **Case 3:** 2 medical risk factors (renal disease and hyperlipidemia) and 2 low risk ocular factors (hyperopia and post-vitrectomy).
 - **Case 4:** 3 medical risk factors (hypertension, gout and ischemic heart disease) and 2 low risk ocular factors (shallow anterior chamber and diabetic retinopathy).

Guided discovery approach

- The 3 mental models are presented through *questioning* by the faculty and using **concept maps**.
- The resident is guided by **leading questions** to discover and to better understand the *relationship between the various presented information* e.g. how a low risk ocular factor influences the type of investigation to be ordered. Answers and explanations will be given at the end if necessary. The 3 domain models are presented through this approach:
 - Conceptual models:** knowing the concept of medical and low risk ocular factors, their effects on cataract surgery and how to optimise them pre-operatively.
 - Structural models:** knowing pre-operative management options for different complicated cataracts including clinical work-up (history-taking, eye examination, investigations) and the solutions to optimise the ocular risk factors to prepare for surgery.
 - Causal models:** interpreting clinical and eye diagnostic test findings and understanding how they influence the management options through constructing the relevant illness scripts.

Supportive information 2.2:

Presentation of **mental/ domain models**

- **Text book (Practical Ophthalmology: A Manual for Beginning Residents, 7th Edition. American Academy of Ophthalmology, 2017), Chapter 9 on "Lens".**
 - **Conceptual models:** e.g. knowledge on *ocular risk factor* causing cataract surgery complication and influencing the management plan.
 - **Structural models:** e.g. linking *ocular risk factors* to investigations then to management plans.
 - **Causal models:** e.g. how *ocular risk factors* result in potential surgical complication.
- This reinforces the learnings from the case discussion and the students are *instructed beforehand to compare* what they have learned with the text book information.
- The resident refers to it for clarifying or finding new information i.e. it functions as a learning resource.

Supportive information 2.3:

Presentation of **mental/ domain models**

E-learning resource. Available on the Eye Electronic Learning Centre.

- **Atlas of Ophthalmology:** an electronic atlas to learn the management of different *cataract types* and *low risk ocular factors*. The *clinical signs of different ocular factors* are taught to improve the learner's diagnostic accuracy. The required investigations and treatment for various eye conditions are explained. (refer to the "lens" section).
- **Conceptual models:** e.g. post-operative complication from diabetes mellitus exemplifies the concept of an ocular risk factor.
- **Structural models:** e.g. linking ocular risk factors to investigations and management plans.
- **Causal models:** e.g. how an ocular risk factor causes operative complication.

Guided discovery approach

- A set of *study questions* (**leading questions**) will be posed at the end of each case to guide/ lead the students into discovering the *relationships between the presented information* with regard to the above 3 models.
- *Answers and explanations* will be given at the end if necessary.

Supportive information 2.4:

Presentation of **cognitive strategies**

Modelling examples (*process-orientated* learner support).

Instructional video. Available on the Eye Electronic Learning Centre.

- Topic: **Clinical work-up** for patients with moderate cataract and different medical and low risk ocular factors.
- Experts *performs the constituent skills* in the **clinical work-up** (*history-taking, eye examination and investigations*) for 4 different patients and explaining their rationale for various steps in the management plan.
 - **Case 1:** 1 medical risk factors (diabetes) and 1 low risk ocular factor (myopia).
 - **Case 2:** 1 medical risk factor (ischemic heart disease) and 2 low risk ocular factors (hyperopia and glaucoma).
 - **Case 3:** 2 medical risk factors (gout and renal disease) and 2 low risk ocular factors (myopia and post-vitrectomy).
 - **Case 4:** 3 medical risk factors (diabetes, gout and hypertension) and 3 low risk ocular factors (hyperopia, shallow anterior chamber and diabetic retinopathy).
- The various components of *history-taking, eye examination* (relevant ones) and *ordering investigations* that needs to be modified to **manage the low risk ocular factors** are explained.

Guided discovery approach

After the case presentations, the learner is guided by **leading questions** to discover the following:

- **SAPs:** the approaches to do *clinical work-up* of cases with different low risk ocular factors and medical risk factors.
- **Rules-of-thumb:** the necessary *eye examinations* and *investigations* in the clinical work-up for medical risk factors and for low risk ocular factors to optimise the patient for cataract surgery.
- *Answers and explanations* will be given at the end if necessary.

Problem-based knowledge test. (Available on the Eye Electronic Learning Centre)

- **Worked examples** (common clinic cases) are used to assess the students' baseline knowledge, and introduce the *task class content* and *performance standards*.
- Test formats include MCQs, fill-in-the-blanks and sorting choices.
- Feedback on the answers (based on the expert's opinion) are given at the end of the test.

<p>Learning Task 2.1: <i>Case method (small group case discussion)</i> 3 worked-out examples (case studies):</p> <ol style="list-style-type: none"> 1. Patient with <u>moderate</u> posterior sub-capsular cataract and <u>1 medical and 1 ocular risk factors</u> (hypertension and shallow anterior chamber). 2. Patient with <u>moderate</u> nuclear cataract, <u>1 medical and 2 ocular risk factors</u> (uncontrolled diabetes; high myopia and mild diabetic retinopathy) 3. Patient with <u>moderate</u> cortical and nuclear cataract with <u>2 medical and 2 ocular risk factors</u> (hypertension and ischemic heart disease; hyperopia and controlled glaucoma). <p>- The video-based examples are used to illustrate the pre-operative management (all 3 skill clusters required) of different clinic cases (<i>task class 2 complexity</i>) by experts.</p> <p>- Goal: The resident studies the cases and explains how the <i>domain elements</i> are related to each other. e.g. how a medical risk factor links to certain investigations</p> <p>- Side-task: the residents comment on and discusses peer performances (<i>peer assessment</i>).</p> <ul style="list-style-type: none"> • Cognitive feedback (<i>reflective prompts</i>). 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Resident handbook: the section on: <ul style="list-style-type: none"> - the steps to manage various low risk ocular factors. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Regular Eye Clinic: <ul style="list-style-type: none"> - The <i>faculty selects</i> patients of task class 2 complexity for the resident to practise the relevant constituent skills (part-task) under supervision.
<p>Learning Task 2.2: <i>Practice on clinic patient number 1</i> <u>Moderate</u> cataract (e.g. <i>cortical</i> cataract), <u>1 medical risk factor and 2 low risk ocular factor</u> in the <i>teaching clinic</i>.</p> <p>- The patient is <i>pre-selected by the faculty</i> from the regular clinic.</p> <p>- Goal: The resident demonstrates the ability to perform all 3 skill clusters <u>under direct supervision</u> but <i>focuses on clinical work-up (SC-A)</i>.</p> <ul style="list-style-type: none"> • Cognitive feedback (<i>reflective prompts</i>) 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Resident handbook: the sections on: <ul style="list-style-type: none"> - the steps to manage various low risk ocular factors. - the steps in referring to another medical discipline to control medical risk factors. ❖ Immediate corrective feedback by the faculty on the recurrent skills e.g. funduscopy to diagnose retinopathy. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Regular Eye Clinic: <ul style="list-style-type: none"> - The <i>faculty selects</i> patients of task class 2 complexity for the resident to practise the relevant constituent skills (part-task) under supervision.
<p>Formative assessment (OCEX)</p> <p>- Clinical work-up skills on 2 patients in the <i>regular clinic</i>. One patient on <i>history-taking</i> and another on <i>eye examination</i>.</p> <p>- The cases are selected by <i>the faculty</i> in the regular clinic.</p>	<ul style="list-style-type: none"> - Sub-goaling: residents specify what the <i>next sub-goal</i> of a procedure is e.g. examining for low risk ocular factors after diagnosing a cataract on slit-lamp bio-microscopy.

<p>Supportive information 2.5: Presentation of cognitive strategies Instructional video. Available on the Eye Electronic Learning Centre. Small group learning</p> <ul style="list-style-type: none"> - Topic: Counselling and pre-operative planning in patients with moderate cataract, medical risk factor(s) and low risk ocular factors. - Video demonstrations of experts doing counselling and pre-operative planning in the same 4 patients (from supportive information 2.4). - The various components of <i>counselling</i> (medical and surgical), <i>surgical listing and preparation</i> (e.g. e-referral to another specialist, consent-taking) and <i>lens implant selection</i> (e.g. analysis biometry results and selecting an implant based on target refraction) are explained. <p>Deductive-inquisitory approach</p> <ul style="list-style-type: none"> - The faculty summarises and presents the SAPs (clinical approaches) for various task aspects to manage patients of task class 2 complexity. - The residents are asked to give examples of authentic cases they managed in the regular clinics using the SAPs for various task aspects and explain the rationale for them. 	
<p>Learning Task 2.3: Practice on clinic patient number 2 <u>Moderate cataract</u> (e.g. <i>posterior sub-capsular cataract</i>), <u>2 medical risk factors</u> and <u>1 low risk ocular factors</u> in the <i>teaching clinic</i>.</p> <ul style="list-style-type: none"> - The patient is <i>pre-selected by the faculty</i> from the regular clinic. - Goal: The resident demonstrates the ability to perform all 3 skill clusters under direct supervision but <i>focuses on counselling (SC-B)</i>. • Cognitive feedback# (<i>reflective prompts</i>). 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Resident handbook: the sections on: <ul style="list-style-type: none"> - the steps to manage various low risk ocular factors (<i>fading</i>). - the steps in referring to another medical discipline to control medical risk factor(s) (<i>fading</i>). ❖ Immediate corrective feedback by the faculty on the recurrent skills e.g. explaining the cataract surgery procedure. <p>Part-task practice:</p> <ul style="list-style-type: none"> • +Regular Eye Clinic: <ul style="list-style-type: none"> - The <i>faculty selects</i> patients of task class 2 complexity for the resident to practise the relevant constituent skills (part-task) under supervision. - Attention-focusing: the resident is asked to focus on the crucial aspects of counselling e.g. explaining certain blinding surgical complications.
<p>Formative assessment (OCEX)</p> <ul style="list-style-type: none"> - Counselling skills on 2 patients in the <i>regular clinic</i>. One patient on <i>medical counselling</i> and another on <i>eye surgical counselling</i>. - The cases are selected <i>by the faculty</i> in the regular clinic. 	
<p>Learning Task 2.4: Practice on clinic patient number 3 <u>Moderate cataract</u> (e.g. <i>nuclear cataract</i>), <u>1 medical risk factor</u> and <u>2 low risk ocular factors</u> in the <i>teaching clinic</i>.</p> <ul style="list-style-type: none"> - The patient is <i>pre-selected by the faculty</i> from the regular clinic. - Goal: The resident demonstrates the ability to perform all 3 skill clusters under indirect supervision but <i>focuses on pre-operative planning (SC-C)</i>. 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Resident handbook: the sections on: <ul style="list-style-type: none"> - the steps to informed consent-taking in patients with low risk ocular factor(s). ❖ Corrective feedback is <i>solicited by the learner</i> from the supervisor during/after performing the recurrent skill aspects as indicated. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Independent part-task practice in the regular clinics

<p>- Sub-goal: to know the indications for using different intra-ocular lens implants</p> <ul style="list-style-type: none"> • Cognitive feedback# (<i>reflective prompts</i>). 	<ul style="list-style-type: none"> - The <i>learner selects</i> appropriate patients to do part-task practice of recurrent skills that are <u><i>self-assessed</i></u> to be deficient and seek the necessary procedural information from the faculty and/or the Eye Electronic Learning Centre. - Matching: the resident <i>compares and contrasts</i> correct procedural demonstrations with the wrong ones e.g. between a correct and wrong lens implant selection.
<p>Formative assessment (OCEX)</p> <ul style="list-style-type: none"> - Pre-operative planning skills on 2 patients in the <i>regular clinic</i>. One patient on <i>consent-taking</i> and another on <i>lens implant selection</i>. - The <i>resident selects</i> his/her own patients for assessment by the faculty. 	<p>Procedural information:</p> <ul style="list-style-type: none"> ▪ Resident handbook: the sections on: <ul style="list-style-type: none"> - the steps to informed consent-taking in patients with low risk ocular factor(s) (<i>fading</i>). ▪ Corrective feedback is <i>solicited by the learner</i> from the supervisor during/after performing the recurrent skill aspects as indicated. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Independent part-task practice in the regular clinics <ul style="list-style-type: none"> - The <i>resident selects</i> appropriate patient(s) to do part-task practice of recurrent skills that are <u><i>self-assessed</i></u> to be deficient and seeks the necessary procedural information from the faculty and/or the Eye Electronic Learning Centre. ▪ Recognise-edit-produce sequencing (Grooper, 1983). <ul style="list-style-type: none"> - The resident <i>recognises</i> and applies a cognitive rule in a familiar situation (e.g. mobile patient), <i>edits</i> it in an unfamiliar situation (e.g. non-ambulatory patient) then <i>produces</i> solutions to do the part-task (e.g. do eye examination with portable eye instruments).
<p>Learning Task 2.5: <i>Practice on clinic patient number 4</i> <u>Moderate cataract</u> (e.g. <i>cortical cataract</i>), <u>2 medical risk factors</u> and <u>1 low risk ocular factor</u> in the <i>teaching clinic</i>.</p> <ul style="list-style-type: none"> - The patient is <i>pre-selected by the faculty</i> from the regular clinic. - Goal: The resident demonstrates the ability to perform all 3 skill clusters <u><i>under indirect supervision</i></u>. • Cognitive feedback (questioning based on <u><i>counter-examples</i></u>). 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Corrective feedback is <i>solicited by the learner</i> from the supervisor during/after performing the recurrent skill aspects as indicated. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Independent part-task practice in the regular clinics <ul style="list-style-type: none"> - The <i>resident selects</i> appropriate patient(s) to do part-task practice of recurrent skills that are <u><i>self-assessed</i></u> to be deficient and seeks the procedural information from the faculty and/or the Eye Electronic Learning Centre.
<p>Formative assessment (OCEX)</p> <ul style="list-style-type: none"> - Managing a cataract patient (all 3 skill clusters required) with task class 2 complexity in the <i>regular clinic</i>. - The <i>resident selects</i> his/her own patient for assessment by the faculty. 	
<p>Learning Task 2.6: <i>Conventional case</i> <i>Practice on a clinic patient</i> with <u>task class 2 complexity</u> in the <i>regular clinic</i>.</p> <ul style="list-style-type: none"> - The patient is <i>pre-selected by the faculty</i> from the regular clinic. - Goal: The resident demonstrates the ability to perform all 3 skill clusters <u><i>independently</i></u>. • Cognitive feedback (<i>Questioning based on hypothetical cases</i>). 	

<p>Formative assessment (OCEX)</p> <ul style="list-style-type: none">- Managing a cataract patient (all 3 skill clusters required) with task class 2 complexity in the <i>regular clinic</i>.- The <i>resident selects</i> his/her own patient for assessment by the faculty.	<ul style="list-style-type: none">▪ Recognise-edit-produce sequencing- This <i>fading strategy</i> is applied for other situations e.g. changing the <i>pupil examination technique</i> for fixed unreactive pupils; using a <i>portable tonometer</i> to check eye pressure in dementia patients.-
<p>40-item vignette-based MCQ test. (Available on the Eye Electronic Learning Centre)</p> <ul style="list-style-type: none">- Formative assessment with a with answers and explanation.- The questions are derived from <i>real-life clinical case scenarios</i> to test the <i>understanding</i> and <i>application</i> of knowledge in various constituent skills.	

Task Class 3: Pre-operative management of patients with severe cataract, medical risk factor(s), mental risk factor(s) and high risk ocular factor(s).

- Patients with *severe* cataract and significant visual compromise requiring cataract surgery.
- Patient with uncontrolled *medical risk factors(s)* e.g. hypertension, diabetes, ischemic heart disease, rheumatoid arthritis.
- Patient has *high risk ocular factor(s)* e.g. small pupils, lax lens zonules, uncontrolled glaucoma, severe diabetic retinopathy, floppy iris syndrome, vitreous haemorrhage.
- Patient has *mental risk factor(s)* e.g. dementia, anxiety disorder, obsessive compulsive neurosis, autism, psychosis.

Supportive information 3.1:

Presentation of **cognitive strategies**

Modeling example (*process-orientated learner support*).

Instructional video. Available on the Eye Electronic Learning Centre.

- Topic: **Clinical work-up for complicated cataracts with medical, ocular and mental risk factors.**
- Experts *performs the constituent skills* in the **clinical work-up** (history-taking, eye examination and investigations) for 4 different patients and explaining their rationale for various steps in the management plan.
 - **Case 1:** 2 mental risk factors (dementia and anxiety disorder), 1 high risk ocular risk factor (small pupil) and 1 medical risk factor (hypertension).
 - **Case 2:** 1 mental risk factor (autism), 2 high risk ocular factors (small pupil and severe diabetic retinopathy) and 2 medical risk factors (ischemic heart disease and diabetes).
 - **Case 3:** 2 mental risk factors (obsessive compulsive neurosis and anxiety disorder), 2 high risk ocular factors (lax zonules and uncontrolled glaucoma) and 3 medical risk factors (hypertension, gout and ischemic heart disease).
 - **Case 4:** 1 mental risk factor (psychosis), 3 high risk ocular factors (small pupil, lax lens zonules and severe diabetic retinopathy) and 2 medical risk factors (rheumatoid arthritis and gout).

Guided discovery approach

The learner is **guided** by **leading questions** in a quiz after the 4 case presentations to discover the following:

- **Systemic approaches to problem-solving (SAPs):** how to do **clinical work-up** (history-taking, eye examination and investigations) for different *high risk ocular factors* and *mental risk factors* to prepare for safe surgery.
- **Rules-of-thumb:** the necessary *eye examinations* and *investigations* in the **clinical work-up** for medical risk factors and for high risk ocular factors to optimise the patient for cataract surgery; understanding how the clinical findings and test results influence the management options (e.g. choosing general anaesthesia for the surgery).

Answers and explanations will be given after responding to each question.

Supportive information 3.2:

Presentation of **cognitive strategies**

Modelling example (*process-orientated learner support*).

Instructional video. Available on the Eye Electronic Learning Centre.

- Topic: **Counselling patients with complicated cataracts, high risk ocular factors and mental risk factors for surgery.**
- Experts *performs the constituent skills* in **counselling** in the **same 4 cases** in supportive information 3.1.

Guided discovery approach

- The learner is **guided** by **leading questions** in a quiz after the 4 case presentations to discover the following:
 - **Systemic approaches to problem-solving (SAPs):** how to do **counselling** of cases for different high risk ocular factors and for different mental risk factors e.g. surgical and anaesthetic complications to expect.
 - **Rules-of-thumb:** understanding how various risk factors (ocular and medical) affect the **counselling** of patients with complicated cataract on the pre-, intra- and post-operative measures to optimise surgical success.

Answers and explanations will be given after responding to each question.

Supportive information 3.3:

Presentation of **mental/ domain models**

Text book (Practical Ophthalmology: A Manual for Beginning Residents, 7th Edition. American Academy of Ophthalmology, 2017), Chapter 9 on “Lens”.

- **Conceptual model:** e.g. knowledge on mental risk factor *complicating cataract surgery* and affecting the management plan.
- **Structural model:** e.g. linking medical risk factors to different *investigations* then to management plans.
- **Causal model:** e.g. how a high risk ocular factor *alters the clinical signs* due to cataract.
- This *reinforces the learnings* from the case discussion and the students are instructed beforehand to **compare** what they have learned with the text book information. The resident refers to it for clarifying or finding new information.

Supportive information 3.4:

Presentation of **domain/ mental models**

Online resource. Available on the Eye Electronic Learning Centre.

- **Atlas of Ophthalmology:** a free, electronic atlas to learn different cataract and their management plan. The *clinical signs of different eye conditions* are taught to improve diagnostic accuracy. The required investigations and treatment for various diagnosed cataract types are explained. (refer to the “lens” section).
- **Conceptual model:** e.g. post-operative complication from dementia exemplifies the concept of mental risk factor.
- **Structural model:** e.g. linking mental risk factors to counselling and management plans.
- **Causal model:** e.g. how a mental risk factor causes operative complication.

Guided discovery approach

- A set of *study questions (leading questions)* will be posed at the end of each case to **guide/ lead** the students into discovering the *relationships between the presented information* with regard to the above 3 models.
- *Answers and explanations* will be given after the resident responds to a question.

Supportive information 3.5:

Presentation of **cognitive strategies**

Modelling example (process-orientated learner support).

Instructional video. Available on the Eye Electronic Learning Centre.

- Topic: **“Pre-operative planning in different patients with complicated cataracts, and different mental, ocular and medical risk factors”.**
- Experts *performs the constituent skills* in **pre-operative planning** in the **4 complicated cases**.
 - **Case 1:** 1 mental risk factor (psychosis), 2 high risk ocular factors (uncontrolled glaucoma and severe diabetic retinopathy) and 2 medical risk factors (ischemic heart disease and diabetes).
 - **Case 2:** 2 mental risk factors (dementia and anxiety disorder), 1 high risk ocular risk factor (lax lens zonules) and 1 medical risk factor (ischemic heart disease).
 - **Case 3:** 2 mental risk factors (dementia and obsessive compulsive neurosis), 2 high risk ocular factors (small pupil and floppy iris syndrome) and 3 medical risk factors (diabetes, hypertension and gout).
 - **Case 4:** 1 mental risk factor (anxiety disorder), 3 high risk ocular factors (floppy iris syndrome, small pupil and uncontrolled glaucoma) and 2 medical risk factors (ischemic heart disease and rheumatoid arthritis).
- The various components of surgical listing and preparation (e.g. consent-taking) and lens implant selection (e.g. analysing ultra-sonography results and selecting an implant) are explained.

Guided discovery approach

After the case presentations, the learner is guided by **leading questions** in a quiz to discover the following:

- **Systemic approaches to problem-solving (SAPs):** how to do pre-operative planning for different high risk ocular factors and for different mental risk factors to prepare for safe surgery.
- **Rules-of-thumb:** understand how the clinical work-up findings influences the surgical plan.

Answers and explanations will be given after the resident responds to a question.

<p>Problem-based knowledge test. (Available on the Eye Electronic Learning Centre)</p> <ul style="list-style-type: none"> - Worked examples (common clinic cases) are used to assess the students' baseline knowledge, and introduce the <i>task class content</i> and <i>performance standards</i>. - Test formats include MCQs, fill-in-the-blanks and sorting choices. - Feedback on the answers (based on the expert's opinion) are given at the end of the test. 	
<p>Learning Task 3.1: Practice on clinic patient number 1 Severe cataract (e.g. <i>posterior sub-capsular cataract</i>), 1 medical risk factor, 1 high risk ocular factor and 1 mental risk factor in the <i>teaching clinic</i>.</p> <ul style="list-style-type: none"> - The patient is <i>pre-selected by the faculty</i> from the regular clinic. - Goal: The resident demonstrates the ability to perform all 3 skill clusters under direct supervision but focuses on clinical work-up (SC-A). • Cognitive feedback (reflective prompts) 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Resident handbook: the section on: <ul style="list-style-type: none"> - the steps to manage various high risk ocular factors. ❖ Immediate corrective feedback by the faculty on the recurrent skills. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ +Regular Eye Clinic: <ul style="list-style-type: none"> - The <i>faculty selects</i> patients for the resident to practise the relevant constituent skills under supervision. - Sub-goaling: residents specify what the next sub-goal of a procedure is e.g. examining for high risk ocular factors after diagnosing a cataract on slit-lamp bio-microscopy.
<p>Formative assessment (OCEX)</p> <ul style="list-style-type: none"> - Clinical work-up skills on 2 patients in the <i>regular clinic</i>. One patient on <i>history-taking</i> and another on <i>eye examination</i>. - The cases are selected by <i>the faculty</i> in the regular clinic. 	
<p>Learning Task 3.2: Practice on clinic patient number 2 Severe cataract (e.g. <i>nuclear cataract</i>), 1 medical risk factor, 1 high risk ocular factor and 1 mental risk factor in the <i>teaching clinic</i>.</p> <ul style="list-style-type: none"> - The patient is <i>pre-selected by the faculty</i> from the regular clinic. - Goal: The resident demonstrates the ability to perform all 3 skill clusters under direct supervision but focuses on counselling (SC-B). - Sub-goal: to identify salient points in counselling for general anaesthesia and operative complications. • Cognitive feedback (reflective prompts) 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Resident handbook: the section on: <ul style="list-style-type: none"> - the steps to manage various high risk ocular factors (fading). - the steps to refer to another medical discipline to control medical and/or mental risk factors. - the steps informed consent-taking in patients with mental risk factor(s) including for general anaesthesia. ❖ Corrective feedback is <i>solicited by the learner</i> from the faculty during/after performing the recurrent skill aspects as indicated. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ +Regular Eye Clinic: <ul style="list-style-type: none"> - The <i>faculty selects</i> patients for the resident to practise the relevant constituent skills under supervision. - Attention-focusing: the resident is asked to focus on the important aspects of counselling e.g. explaining the surgical complications associated with the high risk ocular factors.
<p>Formative assessment (OCEX)</p> <ul style="list-style-type: none"> - Counselling skills on 2 patients in the <i>regular clinic</i>. One patient on medical counselling and another on eye surgical counselling - The cases are selected by <i>the faculty</i> in the regular clinic. 	

Supportive information 3.6:

Presentation of **cognitive strategies**

Small group learning

- Topic: **Management of patients with severe cataract, medical risk factors, high risk ocular factors and mental risk factors.**

Deductive-inquisitory approach

- The faculty summarises and presents the *SAPs* for various task aspects (e.g. clinical work-up, counselling, pre-operative planning) to manage patients of task class 3 complexity.
- The residents are asked to *give examples* of authentic cases they managed in the regular clinics *using the SAPs* for various task aspects, and *explain the rationale* for them e.g. how and why they counsel differently with various mental risk factors.

Answers and explanations will be given after the resident responds to a question.

- **Side-task:** The residents do *peer assessment* and compare their answers with their peers.

Learning Task 3.3:

Practice on clinic patient number 3

Severe cataract (e.g. nuclear cataract), 1 medical risk factor, 2 high risk ocular factors and 1 mental risk factor in the *teaching clinic*.

- The case is *pre-select by the resident* from the regular clinic.

- **Goal:** The resident demonstrates the ability to perform **all 3 skill clusters** under indirect supervision but *focuses on pre-operative planning (SC-C)*.

- **Sub-goal:** to know the indications for using different intra-ocular lens implants

- **Cognitive feedback** (*reflective prompts*).

Formative assessment (OCEX)

- **Pre-operative planning** skills on **2 patients** in the *regular clinic*. One patient on consent-taking and another on lens implant selection.

- The cases are selected *by the faculty* in the regular clinic.

Learning Task 3.4:

Practice on clinic patient number 4

Severe cataract (e.g. anterior sub-capsular cataract) with 3 medical risk factors, 1 high risk ocular factor and 2 mental risk factors in the *teaching clinic*.

- The case is *pre-select by the resident* from the regular clinic.

- **Goal:** The resident demonstrates the ability to perform **all 3 skill clusters** under indirect supervision.

Procedural information:

- ❖ **Resident handbook:** the section on:
 - the steps to **refer to another medical discipline** to control medical and/or mental risk factors (**fading**).
 - the steps **informed consent-taking** in patients with mental risk factor(s) including for general anaesthesia (**fading**).
- ❖ **Corrective feedback** is *solicited by the learner* from the faculty during/after performing the recurrent skill aspects as indicated.

Part-task practice:

- **Independent part-task practice in the regular clinics**
 - The *learner selects* appropriate patients to do **part-task practice** of recurrent skills that are self-assessed to be deficient and seek the necessary procedural information from the faculty and/or the Eye Electronic Learning Centre.

-**Sub-goaling:** residents specify what the *next sub-goal* of a procedure is e.g. examining for high risk ocular factors after diagnosing a cataract on slit-lamp bio-microscopy.

Procedural information:

- ❖ **Corrective feedback** is *solicited by the learner* from the supervisor during/after performing the recurrent skill aspects as indicated.

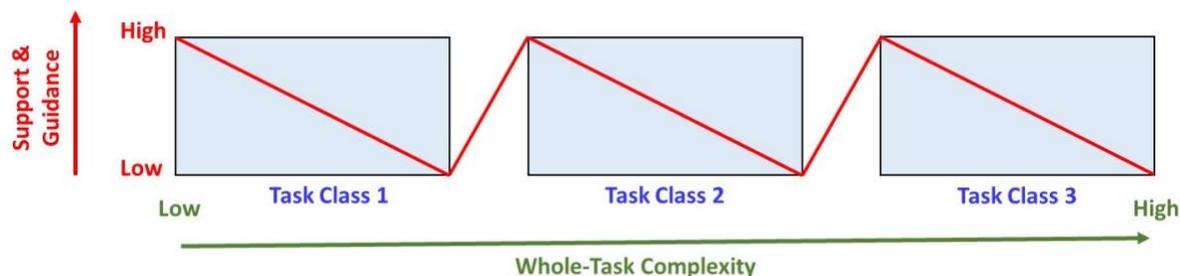
Part-task practice:

- **Independent part-task practice in the regular clinics**
 - The *learner selects* appropriate patients to do **part-task practice** of recurrent skills that are self-assessed to be

<p>- Side tasks: The faculty gives <i>discussion topics</i> to encourage <i>peer learning and reflection</i> in the students.</p> <ul style="list-style-type: none"> • Cognitive feedback (questioning based on <u>counter-examples</u>). 	<p><u>deficient</u> and seek the necessary procedural information from the faculty and/or the Eye Electronic Learning Centre.</p> <p>- Matching: the resident <i>compares and contrasts</i> correct procedural demonstrations with the wrong ones e.g. commenting on the differences between a right and a wrong examination technique to detect a high risk ocular factor.</p>
<p>Formative assessment (OCEX)</p> <p>- Managing a cataract patient (using 3 skill clusters) with task class 3 complexity with in the <i>regular clinic</i>.</p> <p>- The <i>resident selects</i> his/her own patient for assessment by the faculty.</p>	
<p>Learning Task 3.5</p> <p><i>Conventional task</i></p> <p>Practice on clinic patient number 4</p> <p><u>Severe</u> cataract with <u>multiple</u> risk factors (medical, ocular and mental) in the <i>regular clinic</i>.</p> <p>- The case is <i>pre-select</i> by the resident from the regular clinic.</p> <p>- Goal: The resident demonstrates the ability to perform all 3 skill clusters <u>independently</u>.</p> <ul style="list-style-type: none"> • Cognitive feedback (<i>Questioning based on hypothetical cases</i>). 	<p>Procedural information:</p> <ul style="list-style-type: none"> ❖ Corrective feedback is <i>solicited by the learner</i> from the supervisor during/after performing the recurrent skill aspects as indicated. <p>Part-task practice:</p> <ul style="list-style-type: none"> ▪ Independent part-task practice in the regular clinics - The <i>learner selects</i> appropriate patients to do part-task practice of recurrent skills that are self-assessed to be <u>deficient</u> and seek the necessary procedural information from the faculty and/or the Eye Electronic Learning Centre. <p>Recognise-edit-produce sequencing.</p> <ul style="list-style-type: none"> - This <i>fading strategy</i> is applied for various situations e.g. changing the fundus examination technique in a patient with high risk ocular factor like small pupil, adjusting the ultra-sound machine settings to examine an eye with vitreous haemorrhage (bleeding).
<p>Formative assessment (OCEX)</p> <p>- Managing a cataract patient (using 3 skill clusters) with task class 3 complexity with in the <i>regular clinic</i>.</p> <p>- The <i>resident selects</i> his/her own patient for assessment by the faculty.</p>	
<p>40-item vignette-based MCQ test. (Available on the Eye Electronic Learning Centre)</p> <ul style="list-style-type: none"> - Formative assessment with a with answers and explanation. - The questions are derived from <i>real-life clinical case scenarios</i> to test the <i>understanding</i> and <i>application</i> of knowledge in various constituent skills. 	

Annex 6. The saw-tooth pattern of scaffolding.

More support and guidance is given at the start but is diminished with increasing learner's expertise in each task classes. The repetitive pattern of decreasing support and guidance with time in the 3 task classes produces a **saw-tooth pattern**.



Annex 7. Assessment tools for the EPA-based Learning Module in first year Eye Residents

	Assessment Aspect	Assessment Tool	
		Formative	Summative
Domain-specific Skills	Supportive Information (cognitive strategies)	Key Feature Question (Oral Quiz), OCEX*	Vignette-based MCQ Test, Portfolio
	Supportive Information (mental models)	Concept Map	Vignette-based MCQ Test, Portfolio
	Procedural Information and Part-task	OCEX*	OSCE, Portfolio
Domain-general Skills	Self-assessment, Peer assessment and Task Selection Skills	Direct Observation Portfolio	Portfolio

Legend:

- Ophthalmic Clinical Evaluation eXercise (OCEX*)** is validated formative workplace-based assessment tool (Golnik & Goldenhar, 2005). Only the *recurrent-to-be automated part-tasks* e.g. history-taking, eye examination, counselling skills are assessed, and not all part-tasks and procedural information. They assess at the “does” Miller’s pyramid level for the accuracy, speed and time-sharing ability (i.e. concomitant execution with other skills).

Annex 8. The Ophthalmic Clinical Evaluation Exercise (OCEX) rubric. Taken from (Golnik & Goldenhar, 2005).

<p>The OCEX is an observed encounter between a resident and a new patient. The evaluator should be present in the exam room for the entire interaction. The intent is to rate the resident in all the categories listed below and then provide immediate performance feedback. The rating system is:</p> <p>1 - Does Not Meet Expectations 3 - Meets All Expectations 2 - Meets Some Expectations 4 - Exceeds Expectations na - Not Applicable</p>													
Interview Skills													
1. Introduced self	1	2	3	4	na	7. Review of systems	1	2	3	4	na		
2. Obtained chief complaint	1	2	3	4	na	8. Medicine list	1	2	3	4	na		
3. History of present illness	1	2	3	4	na	9. Past medical history	1	2	3	4	na		
4. Pertinent negatives	1	2	3	4	na	10. Social history	1	2	3	4	na		
5. Pain inquiry	1	2	3	4	na	11. Family history	1	2	3	4	na		
6. Allergies	1	2	3	4	na	12. Washed hands	1	2	3	4	na		
Examination													
1. Best corrected acuity	1	2	3	4	na	5. External	1	2	3	4	na		
2. Pupils / RAPD	1	2	3	4	na	6. Slit lamp exam	1	2	3	4	na		
3. Visual Fields	1	2	3	4	na	7. IOP (+/- gonioscopy)	1	2	3	4	na		
4. Motility	1	2	3	4	na	8. Funduscopy	1	2	3	4	na		
Interpersonal Skills / Professionalism													
1. Empathetic	1	2	3	4	na	5. Explained diagnosis	1	2	3	4	na		
2. Respectful & courteous	1	2	3	4	na	6. Explained plan/options	1	2	3	4	na		
3. Used language the patient understands	1	2	3	4	na	7. Asked if patient had questions	1	2	3	4	na		
4. Explained findings	1	2	3	4	na								
Case Presentation													
1. Concise & clear	1	2	3	4	na	4. Appropriate differential Dx	1	2	3	4	na		
2. Pertinent facts	1	2	3	4	na	5. Appropriate plan	1	2	3	4	na		
3. Pertinent pos & negs	1	2	3	4	na	6. Response to attending's questions/suggestions	1	2	3	4	na		
<p>Comments: _____</p> <p>We have reviewed this OCEX together. Resident initials: _____ Evaluator initials: _____</p>													

Legend:

- **OCEX** assesses 4 skill domains: **interview** (12 items), **examination** (8 items), **interpersonal skills/ Professionalism** (7 items) and **case presentation** (clinical reasoning & management plan, 6 items).

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