Abstract
This paper describes considerations behind the organisation of a third semester BSc education. The project aims to facilitate a feedback-oriented environment using assessment for learning and for incremental measure of learner progress [Vleuten et al, 2012, “A model for programmatic assessment fit for purpose”]. Learning outcomes encourage higher order cognitive skills, following [Biggs & Tang, 2011, “Teaching for quality learning at university: what the student does”]. Embracing [Dochy et al, 2018, “Creating Impact Through Future Learning: The High Impact Learning that Lasts (HILL) Model”], several mechanisms encourage focus and motivation.

Key words & Phrases: Learning Outcomes, Programmatic Assessment, Constructive Alignment, High Impact Learning, Making Learning Outcomes, SOLO Taxonomy, Feedback as Teaching, Assessment for Learning, Action Learning

1 Introduction
Traditional methods of teaching seem to be failing (Wolk 2011). In our 2nd-year BSc Cybersecurity education, a number of specific issues were identified. Frontal teaching was becoming less effective: 100 minute attention spans are tough; many students intend to read the slides and books later (but by then time is at a premium); and one-size-fits-all teaching leaves both fast and slow students at a disadvantage. Scheduling multiple classes and multiple projects in a week, and expecting students to move around and even switch teams repeatedly, doesn’t stimulate effective work methods. Exams for all classes at the end of each 8 week period, often at awkward times, heightens both study pressure and exam stress. Mechanisms to aid students who need additional guidance, such as on-demand consultancy, were notably ineffective. Overall, motivation and results were dropping.

Many new educational methods are being developed to improve the efficacy of teaching, learning and assessment, e.g. (Sharples et al. 2015) (Ferguson et al. 2019). To
mention a few examples: methods which control the learning environment (Crossover learning, Self learning); methods which control the learning activities (Learning Through Argumentation, Learning by doing science with remote labs, Adaptive Teaching, Design thinking, Flip the classroom, Gamification); methods which control assessments (Stealth assessment, Analytics of emotions). (Dunne and Martin 2006) (Fulton 2012) (Mitra and Dangwal 2010)

In this paper we incorporate Learning Outcomes (Adam, 2002), (Kennedy, Hyland & Ryan, 2002) and Programmatic Assessment (Vleuten et al., 2012), as a means to increase efficacy. This specific approach shares traits with Crossover Learning, Assessment for Learning, Learning to Learn, Self Learning, Adaptive Teaching, Action Learning and Flip the Classroom. (Sharples et al., 2015), (Ferguson et al., 2019)

In this paper we will refer to this approach as 'the project'. The project is now in its second year running and shows increased student activity and productivity, measurable advancement over the semester and enhanced inter and intra-team communication. Perhaps most importantly, the project stimulates both advanced students and students that require more guidance to grow and excel within their own scope.

Section 2 describes Programmatic Assessment and Section 3 describes Learning Outcomes and their role in the project. Section 4 presents the project in some detail and Section 5 discusses several relevant considerations. Section 6 offers specific guidelines on how to create Learning Outcomes. In Section 7 we briefly address embedding Learning Outcome oriented Programmatic Assessment in an existing context. As far as we are aware, this combination of Programmatic Assessment based on Learning Outcomes, the integration with High Impact Learning, and the process for creating Learning Outcomes using SOLO verbs (Biggs & Collis, 1982) are new.

2 Programmatic Assessment

Programmatic assessment is an integral approach to the design of an assessment program with the intent to optimise its learning function, its decision-making function and its curriculum quality-assurance function (Vleuten, Schuwirth, Driessen, Govaerts & Heeneman, 2014). We use formative assessments as an important learning activity, and summative assessments to base high-stake decisions on – i.e. major pass/fail decisions (Vleuten et al., 2012).

The student receives regular and frequent feedback on products and activities, so that both students and teachers have a clear picture of the student’s progress. Constructive alignment is very important here: the activities (and products produced in them) and the feedback on them must give the student a substantial basis of preparation for
summative tests and of growth with respect to the intended learning results. If constructive alignment is sufficiently high, the feedback itself is an important learning activity.

Following (Vleuten, Schuwirth, Driessen, Govaerts & Heeneman, 2014), the project offers a program of formative and summative feedback which is an integral part (and the main component) of teaching. Students develop four significant team products and five individual essays. Feedback is offered frequently on their work, their way of working and their team process. This feedback includes weekly professional development coaching, technical progress coaching, incidental written and verbal feedback on intermediate products, and written (formal) feedback on individual essays and team products, and finally, peer feedback. In terms of (Earl, 2014) this is Assessment for Learning and Assessment as Learning, and in the end Assessment of Learning. This feedback includes an indication of to the student’s progress with respect to the learning outcomes. The feedback is primarily formative but does have a summative aspect: products and feedback are included in the portfolio that the student builds over the semester. Teachers confer regularly among themselves to objectify feedback and formal feedback on products is provided by two or more teachers. Students that fail to pass on any of the learning outcomes get remedial work aimed specifically at their underdeveloped areas. In principle, feedback is never intended to result in submission of an improved version of the same product. Clearly just processing feedback does not lead to proof at an appropriate professional level. But students can always ask for specific intermediate feedback.

3 Learning Outcomes

Learning outcomes (LO’s) could be described as ‘knowledge students must acquire, understand and be able to reproduce’, e.g., (Adam, 2002). A list of definitions of ‘learning outcomes’ in (Kennedy, Hyland & Ryan, 2002) shows these key concepts: ‘Do / Demonstrate’, ‘Knowledge / Understanding’, ‘Attitude’. For a professional, knowledge and understanding are more an essential means than an end; in Bloom’s taxonomy, application, analysis and even evaluation characterise professionalism more closely. In Creating Significant Learning Experiences (Fink, 2013), an alternative taxonomy aimed at designing college courses is presented. Simplifying, one might say Bloom’s six levels are compressed into Knowledge, Application and Integration, to make space for Human Dimension, Caring and Learning how to Learn. (Biggs & Tang, 2011) speaks of Intended Learning Outcomes in relation to the constructive alignment mentioned earlier. Finally, we follow (Allan, 1996) who distinguishes subject-based outcomes (complex discipline-based outcomes which are capable of being assessed) from personal transferable outcomes, which one might also call professional skills.

Learning outcomes then, describe a demonstration of application, analysis and evalu-
uation, but importantly, learning outcomes describe behavior and attitude.

Students in the project aim to be IT professionals with a specialisation in Cybersecurity. Because of this, two of the four learning outcomes address the two core IT processes: requirements-to-design and design-to-implementation. The third addresses Cybersecurity best practice, and the last professional competencies.

Here, we discuss the first LO in detail; the other three appear in Appendix A.

**LO 1:** *A professional, in close communication with the customer, analyses the actual situation and requirements, advises the customer on possible approaches, and iteratively develops an architecture of secure (cloud) information systems and network infrastructure based on accepted principles and patterns.*

This learning outcome is detailed in a rubric to clarify levels of performance on several contained aspects. For instance, in order to demonstrate ‘adequate’ behavior on this learning outcome, the work of a student should be judged at least adequate in its stakeholder and requirements analysis, approach analysis, progressive development and final documentation.

| Insufficient <5.5 | Marginal 6 | Adequate 7 | Good 8 | Excellent 9+ |
|-------------------|------------|------------|--------|---------------|
| **Inadequately documents requirements only from certain stakeholders’ perspectives** | Records requirements from different stakeholders’ perspective | Elicits, classifies and documents requirements and principles from different stakeholders’ perspective | Elicits, analyses and documents requirements and principles from different stakeholders’ perspective which are clear, complete, correct, and concise | Elicits, analyses and documents requirements and principles from different stakeholders’ perspectives which are complete, correct, clear and concise, and including prioritizing considerations |
| **Chooses an approach that fails to meet various requirements** | Defines an approach that meets most requirements at various levels | Outlines an approach that meets the requirements at most requirements levels, such as processes, systems and infrastructure | Conceives an approach that meets the requirements at all levels, including processes, systems and infrastructure | Composes an approach that meets the requirements at all levels, including processes, systems and infrastructure and excels in relevant quality attributes |
| **Creates inadequate views and/or fails to clearly communicate their approach** | Sketches limited numbers of views to communicate their approach and to collect feedback | Describes analytical views to communicate their approach and to collect and process feedback | Creates and iteratively improves architectural views to communicate a recommended approach and to collect and process stakeholders’ feedback | Formulates comprehensive architectural views to communicate their approach and iteratively collects and integrates stakeholders’ feedback and broader concerns |
| **Produces a recommendation which lacks principles, requirements or a clear approach** | Combines various principles, requirements and a chosen approach into a recommendation | Applies relevant principles, requirements and a chosen approach into a just enough documented recommendation | Integrates principles, requirements and a chosen approach into a professionally documented recommendation | Formulates principles, requirements and a chosen approach into a professionally documented recommendation that offers choice points based on priorities |

*Note: even though the LO’s are abstract and difficult for students to grasp, the LO rubric is shared with students and a workshop aids initial understanding. After that,*
the significant formal and informal feedback build a clear mental model (if not actual understanding) of the learning outcomes. This deviates from common practice, where full disclosure and understanding is presumed from the outset. Understanding the end-terms is an essential part of the learning process.

4 Project

The project aims to maximize the individual learning yield for its participants. We are inspired by (Heilesen (ed) & Andersen (ed), 2015) and (Dochy & Segers, 2018).

- The project covers a semester, or to be precise 19 weeks and 24 ECTS (in our situation the remaining 6 ECTS are spent in generic classes outside the scope of the project).
- Week one is used for team forming and to choose the subject of the first team product. One purpose is to instill a sense of urgency. Following (Blomhøj, Enevoldsen, Haldrup & Møller Nielsen, 2015), students are allowed to self-form teams based on self-chosen subjects (in the field of cybersecurity)
- Also in week one students get a study manual which contains
  - The learning outcomes
  - All deadlines
  - Rules and guidance governing the project and examination
  - Various resources that may be of help
- In the sixteen following weeks (disregarding vacation) students work on:
  - Formal products (part of the portfolio):
    * Five individual essays in which a cybersecurity subject is researched and documented
    * Two solution-oriented team products in which a solution is prototyped and documented
    * Two customer-oriented team products in which a professional advice is produced
    * A project reflection in which significant learning experiences are considered
  - Informal products and activities (aimed to obtain formative feedback only)
Two posters aimed to get peer-feedback and ideas
Several auxiliary products leading to formative feedback (project plan, intermediate versions, plannings, backlogs, meeting notes)

- On a number of occasions students and teams are required to offer peer feedback to products of other students/teams.
- Numerous workshops and guest lectures are organised on professional or technical subjects. Participation isn’t mandatory, and the workshops are recorded and made available.
- In the next to last week, students create their reflection report and portfolio (which contains the nine formal products and all feedback obtained).
- In the final week students have an assessment based on their portfolio, in which the final grade is determined. The assessment is not a technical exam: the teachers and the student are aware of the students professional behavior and technical development. The purpose is:
  - To discuss the reflection, and in particular the way in which the student has dealt with feedback ‘insufficient’ for any recent products
  - To determine an overall grade based on the performance levels for each learning outcome

5 Discussion

A number of important considerations should be mentioned:

Templates

Our students are 17-to-22-year-olds with a high-school or vocational previous education. Their expected model of teaching is conventional: teachers in front of the class telling students what to do. The project is a culture shock. Having to choose subjects, to invent realistic customer situations, to research approaches, to develop solutions and to produce professional documentation feels awkward to them. Some approach teachers and ask for guidelines, templates, detailed explanations and lectures. However, templates too often become todo-lists; any explanation, prepared table of contents or list of common subjects (e.g. ‘common stakeholders’) invites students to focus on and limit themselves to that list or template, rather than looking at it in a more open-ended way. Even without supplying such materials we have to be careful; many students are happy just to copy the first web search hit as a template.

Curriculum

The field of Cybersecurity is broad and rapidly changing. By definition, books are likely to be outdated within a couple of years, if not sooner. For the students, many of the
underlying principles have been covered in year one; for year two the key outcome is the students’ ability to research, analyse and apply new expertise with a professional attitude and behaviour. Material that we cover in workshops and guest lectures, and that we suggest students investigate, is inspired by (CSEC, 2017) and (NIST, 2019).

At the time of writing, control of student’s coverage of this material is incidental. Future research includes the development of a skill tree (a graph representation of curricular subjects and their dependencies, such as in (ACM 2017)) and a mechanism to stimulate students to work on obligatory or optional aspects in this skill tree. Such mechanisms might include a system of badges that students acquire doing (formative) tests and assignments.

Optimistically or Not?

A common model for assessments over the course of a semester is to start out ‘easy’ and progress in complexity and span towards ‘hard’. That way students perform at an increasingly difficult level. This means that a solution to some specific easy problem might be worth a high grade early in the semester but would be graded lower later on, because the complexity or span is subpar at that point in time. Some teachers also believe that it is important to give students the opportunity to get some high grades early on, to get positive self-confirmation.

When students can almost freely choose subjects, this implies the need to evaluate a product in the context of learning outcomes based on the point in time in the semester. This approach tends to become subjective.

In the project, all feedback, from day one, is given with respect to the LO’s as it would be on the final day. In order to avoid negative self-confirmation, a workshop is given to help students interpret these early ‘bad’ grades: at this point in time the qualitative feedback is much more important than an indication of a grade (which is just ‘failing’; as the learning outcome rubric shows there is only one failing grade: <5.5). Experience show students understand this and appreciate receiving an indication of grades at the level of their final test in the semester. In addition this approach serves to heighten the ‘sense of urgency’ that is required and may (with proper guidance) enhance students’ intrinsic motivation.

6 Making Learning Outcomes

This section describes the stepwise process used to create learning outcomes suitable in the context of programmatic assessment.

These learning outcomes are aimed at integral assessment and are not really suitable for small curricular units such as individual classes or specific subjects. Such smaller units are important but tend to direct students’ focus on the short term concern of ‘passing’ subjects, both literally and figuratively. They fragment attention rather than stimulating a holistic view of the learning activities.
Learning outcomes based programmatic assessment stimulate student self management. Guided by teachers, students are themselves able to gauge their level of performance and can make informed choices on how to reach higher levels in a learning outcome rubric.

These learning outcomes are intended for large units of 30 (as in our case) or even 60 ECTS (i.e. an entire year). The learning outcomes are abstract and difficult to grasp for students, so they need time to understand how they should study to grow.

This Takes Time

Learning outcomes are not only difficult to understand for students, but also for teachers. Several iterations are needed to arrive at the right set of LO’s. Not every teacher involved will have the same idea about the assessment program, the curriculum construction or even their ability to allow students to falter and stumble in a feedback-centric project. A teacher who believes in a stringent curriculum will have difficulty accepting learning outcomes which are primarily aimed at behaviour and attitude. Ideally, the LO’s are wrought in a small team in which subject expertise, educational experience and sensitivity to language are combined.

High Level Goals

Step one is a description of a student at the end of the period (semester or year) in a number of lemmas (sentences). This description should be future-proof and allow for developments in the field. Describe each theme process-oriented and strategically. Focus on why rather than what, or indeed how with attention for both normative and selective aspects, in terms of (Walters, 2004). Specific details (the ‘how’) are important but don’t have to be taken up in the LO’s. ‘Comprehensively applies professional considerations’ goes a long way to substantiate detailed mechanisms in any area.

Make sure that the lemmas cover the entire field of expertise and do not overlap; ideally they should be complementary. They are distinguishable from each other and should be regarded in conjunction; they are inseparable. Ideally, there are three to seven LO’s.

It is difficult to express highly abstract LO’s. Do not be tempted to include all details students should learn (and will be tested on). Instead, describe professional behavior that can only be exhibited if someone knows, understands and can apply such details. Students work on creating proof of that behavior for half a year or more. They have to be challenged to dive into the details. Long, elaborate and detailed learning outcomes render this superfluous, since students have already been handed the process on a plate.

Refinement

Often, aspects in the learning outcomes need further refinement, for instance when the LO contains or implies a short list of distinct competences or a container subject. Characterise each of these refinements precisely as that what the course aims at (on this
aspect). A capable and industrious student would reach the *relational level* in the SOLO taxonomy, as discussed below.

**Scales**

For each refinement we will now describe performance at different levels placed in columns under the main learning outcome. There is no specific number of columns, but:

- Too few may deprive students of the challenge to achieve better. If all one can do is pass or fail, excellent students will lose interest.
- Too many would blend into an opaque gradient only expressed as a numeric grade.

In practice four or five columns make sense. Four columns, for example, might describe ‘Insufficient’, ‘Marginal’, ‘Good’ and ‘Excellent’.

The SOLO Taxonomy (Biggs & Collis, 1982) is developed to categorize levels of understanding in Prestructural, Unistructural, Multistructural, Relational and Extended Abstract. The SOLO taxonomy can be used effectively in formulating learning outcomes, and specific verbs can be associated with different cognitive levels of performance. (Biggs, 2019) shows such a framework, and others can be found searching for ‘SOLO verbs’.

Following (Biggs & Collis, 1982) we chose to refine in five columns and present them in the order of increasing levels of understanding. The columns then represent ‘insufficient’, ‘marginal’, ‘adequate’, ‘good’ and ‘excellent’. Some prefer to order columns from left to right from ‘Excellent’, to ‘Failing’, starting with the ‘ideal’ goal. We are unaware of scientific evidence which order is better; in this paper we adopt the order in the SOLO taxonomy, from ‘Failing’ to ‘Excellent’.

The descriptions explained under ‘Refinement’ are placed in the column ‘good’ (it is, after all, what we aim for). Now, for each refinement under a learning outcome, we must describe how a student at a level of understanding other than ‘relational’ might perform. The ‘SOLO verbs’ may help us to characterize performance at different cognitive levels.
It isn’t good enough to simply replace the word ‘good’ by ‘adequate’ or ‘marginal’ because that doesn’t help the student to understand, and it leads to a rubric which is subjective.

It is essential to improve the rubric iteratively, to fine-tune it as a whole and to consider it both horizontally and vertically. Each row must suggest a path of growth for a student. If their performance is marginal, how could they improve it to become good? Each column must ‘ring true’ for an imaginary student that performs at that level of understanding. Many schools and universities offer *excellence programs* to motivate and inspire strong students; in our program the column ‘Excellent’ describes the work and attitude of such students.

**Last step, confront with Professional Field**

So far, these learning outcomes are cognitive artefacts on the drawing board; one has to be suspicious. It is imperative to validate with employers and workers in the field where students may eventually work. Do the learning outcomes describe their performance? Did we miss or overemphasise things?

### 7 Embedding

Implementing this approach in a standing organization may lead to various concerns.

**Students**

- The Learning Outcomes are very abstract and difficult to understand for second-year BSc students. It is important to advance understanding directly, for instance by offering workshops on LO’s, but also indirectly by ensuring that all offered feedback is phrased in terms of the LO’s. Students need to understand how to improve their work and thereby get better results with respect to the LO’s.

- Traditional methods of teaching (and often the methods students are used to) involve students sitting back and relaxing while teachers expound on their trade, then cramming in required reading in the last few weeks before an exam. Students may be dissatisfied in a project where they have to work from day one on a vague and very broad curriculum towards learning outcomes they don’t understand.

- Traditional methods, especially in vocational education, teach by offering templates and to-do lists. Confronted with abstract LO’s and a goal of five essays, students typically ask what such an essay must include or if an example of an essay can be given. Sadly, such ‘help’ tends to limit students’ own inquisitive research.

- Traditional methods could be called *exam-oriented*. In our university, every second-year exam must be offered twice a year, and may be repeated as often as the student is willing to pay tuition. Sadly, this stimulates a mentality where negative feedback can be interpreted as an invitation to ‘just try again’. In our project there are no retakes on individual products; the only way to recover from a failing grade is to
make the next product better, and grades aren’t averaged: the final grade reflects students’ absolute and relative growth.

- Students who do not understand or reflect on feedback may simply try to work harder or just try to work in some other way and may feel increasingly dissatisfied with the lack of progress their hard work leads to. Coaching such students is an important success factor of the entire project!

**Teachers**

- Offering the right level of feedback takes getting used to. It is in the nature of teachers to want to take the student by the hand and guide them to a higher level, but that may be counterproductive. On the other hand there are few things so sad as a student being stuck for days on end. Talking with students, and with other teachers about all students is needed to identify any sore spots. Weekly team meetings can be instrumental in achieving overview.

- Many BSc educations distinguish technical teaching from professional skills teaching (as does ours). It is important to narrow this gap: technical feedback should always fit the learning process of the student. Advanced feedback/information may be given, but the student should be able to incorporate this into their own products.

**Management**

- Students, teachers and parents will complain, for all the reasons mentioned above. Management mainly aiming for happy students and parents may get weak at the knees and push for traditional methods or indeed for lowering the bar. It is important that the teacher community consult daily to react — and ‘proact’ — in order to keep all students on track, preventing or at least predicting dissatisfied students (and parents). Management should endorse the renewals described here and should be kept abreast of all results and issues, especially since formative feedback very often doesn’t appear in formal grading systems and is therefore invisible outside of the project. Regular management briefings should be incorporated.

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Appendices

A Learning Outcomes 3rd semester Cybersecurity

This section describes the intended learning outcomes of the third semester in the Cybersecurity program in the HBO-ICT Bachelor education at the University of Applied Sciences in Amsterdam.

From the perspective of a (Cybersecurity) professional, the learning outcomes describe the effort of aiding a customer with an IT wish to bring about a solution that fulfills their needs. The process and the solution can be professionally substantiated by looking at quality aspects such as security.

In this semester students acquire knowledge and develop skills at a junior level needed to:

- Apply Architectural Methods to improve analysis, communication and maintainability
- Apply (various) Quality Attributes to safeguard system and process requirements
- Implement solutions for information systems within specific time constraints
- Produce well documented solutions which meet the customer’s goals

The learning outcomes are explained in the following process segments. Each segment describes one aspect of the customers’ problem-to-solution paradigm which is related to the HBO-i competence framework. The header of each segment defines the process. The cells elaborate this in greater detail, using key concepts, the academic achievement and the professional knowledge, skills and attitude. The column ‘Good’ represents the intended learning outcomes of the course. It is very important to understand this column in depth, because it is required to offer peers useful feedback and to apply reflection in order to improve the quality of one’s own work. To the left and right of this column different levels of the achievements are described.

Students – and professionals – can apply the scales at any specific time to evaluate their performance. After obtaining feedback, their personal learning goals can be adjusted. Eventually, these scales are also used for the final assessment, at which time each student must at least perform at the ‘Marginal’ level in all categories in order to pass.
1. Architecture

A professional, in close communication with the customer, analyses the actual situation and requirements, advises the customer on possible approaches, and iteratively develops an architecture of secure (cloud) information systems and network infrastructure based on accepted principles and patterns. This professional:

| Insufficient <5.5 | Marginal 6 | Adequate 7 | Good 8 | Excellent 9+ |
|-------------------|------------|------------|--------|--------------|
| Inadequately documents requirements only from certain stakeholders' perspectives | Records requirements from different stakeholders' perspectives | Elicits, classifies and documents requirements and principles from different stakeholders' perspectives | Elicits, analyses and documents requirements and principles from different stakeholders' perspectives which are clear, complete, correct, and concise | Elicits, analyses and documents requirements and principles from different stakeholders' perspectives which are complete, correct, clear and concise, and including prioritizing considerations |
| Chooses an approach that fails to meet various requirements | Defines an approach that meets most requirements at various levels | Outlines an approach that meets most requirements at most levels, such as processes, systems and infrastructure | Considers an approach that meets the requirements at all levels, including processes, systems and infrastructure | Composes an approach that meets the requirements at all levels, including processes, systems and infrastructure and excels in relevant quality attributes |
| Creates inadequate views and/or fails to clearly communicate their approach | Sketches limited numbers of views to communicate their approach and to collect feedback | Describes architectural views to communicate their approach and to collect and process feedback | Creates and iteratively improves architectural views to communicate a recommended approach and to collect project and process stakeholders' feedback | Formulates comprehensive architectural views to communicate their approach and iteratively collects and integrates stakeholders' feedback and broader concerns |
| Produces a recommendation which lacks principles, requirements or a clear approach | Combines various principles, requirements and a clear approach into a recommendation | Applies relevant principles, requirements and a chosen approach into a recommendation | Integrates principles, requirements and a chosen approach into a professionally documented recommendation | Formulates principles, requirements and a clear approach into a professionally documented recommendation that offers choice points based on priorities |

2. Cybersecurity

A professional applies cybersecurity best practices in all recommendations, implementations and management of systems and processes to safeguard quality and security. This professional:

| Insufficient <5.5 | Marginal 6 | Adequate 7 | Good 8 | Excellent 9+ |
|-------------------|------------|------------|--------|--------------|
| Fails to apply relevant cybersecurity considerations in recommendation, documentation, implementation and management activities | Recognizes several cybersecurity considerations in recommendation, documentation, implementation and management activities | Adequately outlines cybersecurity considerations in recommendation, documentation, implementation and management activities | Comprehensively applies cybersecurity considerations in recommendation, documentation, implementation and management activities | Applies industry best practice cybersecurity patterns taking broader concerns into consideration in recommendation, documentation, implementation and management activities |
| Fails to apply relevant quality considerations in recommendation, documentation, implementation and management activities | Identifies various quality considerations in recommendation, documentation, implementation and management activities | Adequately describes quality considerations in recommendation, documentation, implementation and management activities | Comprehensively applies other quality considerations in recommendation, implementation and management activities | Applies industry best practice quality patterns taking broader concerns into consideration in recommendation, documentation, implementation and management activities |
| Fails to safeguard quality attributes in a suitable testing approach | Names quality attributes and a test plan | Follows a procedure to safeguard quality attributes with a repeatable testing approach | Uses a managed testing framework which includes acceptance criteria from the customers' perspective to safeguard quality and other quality considerations | Safeguards quality attributes with a comprehensive and transparent (acceptance) testing framework |
| Omit risk analysis in their work | Sketches a limited risk analysis and mitigation | Includes a risk analysis with mitigations | Performs a thorough risk analysis, including recommended mitigations, which includes both project risks and product risks | Performs a comprehensive risk analysis, including mitigations, which includes not only project risks but also product risks |
### 3. Realisation

Working together with the customer, a professional designs, develops, implements and documents (cloud) information system infrastructure which meet the customer's needs in the context of architecture and quality attributes. This professional:

| Insufficient <5.5 | Marginal 6 | Adequate 7 | Good 8 | Excellent 9+ |
|-------------------|------------|------------|--------|--------------|
| Fails to describe information system infrastructure and components that meet the customer's goals | Sketches information system infrastructure and components | Outlines adequate information system infrastructure and components | Designs information system infrastructure and components which meets the customer's needs in the context of architecture and quality attributes | Designs information system infrastructure and components which exceed the customer's goals in the context of architecture and quality attributes |
| Inadequately or incompletely makes information system components which address few of the customer's goals | Makes information system components addressing some of the customer's goals | Makes adequate information system components based on the design and customer's goals | Develops information system components consistent with their design and the customer's needs | Develops information system components generalising on their design and exceeding customer's goals |
| Installs components and systems which fail to address the customer's goals | Installs components and systems addressing some of the customer's goals | Realises information systems based on the design and customer's goals | Implements information system solutions consistent with their context, design and the customer's needs | Create information system solutions exceeding quality attributes within context, design and their customer's goals |
| Fails to produce adequate documentation of the solution. | Produces basic documentation of the solution | Produces complete but mediocre documentation of the solution. | Produces comprehensive documentation of the solution, including detailed information from relevant stakeholders perspectives | Composes comprehensive documentation of the solution, including detailed justification from various stakeholders perspectives |
### 4. Skills

A professional exhibits expert competencies in communication, planning, and execution of work and in all products, including advice design, development, installation, configuration, integration, testing, deployment, maintenance and management. This professional:

| Insufficient 5.5 | Marginal 6 | Adequate 7 | Good 8 | Excellent 9+ |
|------------------|------------|------------|--------|--------------|
| Fails to consider team, deadline or solution and does not consider risks, the customers’ interests or the interests of society at large. | Considers task, team, deadline or solution and considers risks and the customers’ interests or the interests of society at large. | Works structurally with an eye for task, team, deadline and solution and works creatively, entrepreneurially, adequately considering risks, opportunities, and the customers’ interests as well as the interests of society at large. | Works methodically and its task, team, deadline and solution-oriented is creative / entrepreneurial, has an eye for risks and opportunities, and respect for relevance in customer’s interests as well as the interests of society at large. | Critically prioritizes task, team, deadline and solution-oriented considerations and creatively / entrepreneurially, orchestrates risk considerations, opportunities, customer’s interests and the interests of society at large. |
| Fails to consider their behaviour when given feedback, or to apply their strengths and improve their behaviour and knowledge. | Recognizes their behaviour and is open to feedback, applying their strengths, improving their behaviour and developing their knowledge where needed. | Discusses their professional behaviour and looks to others’ feedback and vision, and accepted standards, applying their strengths, improving their behaviour and developing their knowledge where needed. | Reflects on their own professional behaviour, seeks others’ feedback and vision and incorporates common ICT standards, identifying and applying their own strengths, improving their behaviour and developing their knowledge as needed. | Reflects on their professional behaviour and consistently seeks others’ feedback and vision, and accepted standards, applying and improving their strengths and their behaviour and developing their knowledge where needed. |
| Fails to communicate or allow feedback to register, becoming inadequate in working arrangements and timelines. | Communicates open and listens and supports team efforts. | Adequately communicates clearly, open and sensitive, co-operating others and sharing various working arrangements and realistic timelines. | Communicates clearly, openly and sensitively when interacting with others and shares clear working arrangements and realistic timelines. | Communicates clearly, open, sensitive and empathically, guiding others and formulating clear working arrangements and realistic timelines. |
| Is prejudiced and fails to obtain relevant information, leading to poorly documented work. | Has an open view, adequately obtaining and relating information from reliable sources or own measurement, leading to well documented advice and solutions. | Is inquisitive and has a broad and open view, adequately obtaining and relating relevant information from reliable sources or own measurement, leading to well documented justifiable advice and solutions. | Is inquisitive and views a customer concern in its context from relevant perspectives, obtaining, analysing and relating relevant information from reliable sources or own measurement, leading to well documented advice and solutions. | Is inquisitive and views a concern in its context from multiple relevant perspectives, obtaining, analysing and relating relevant information from reliable sources or own measurement, leading to clearly documented justifiable advice and solutions. |