Generative AI and its Implications for Competencies: Work in Progress

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Mihi

- Hāere mai, Haere Mai, Haere Mai.
- Tēnā koutou katoa.
- Ko Tony Clear taku ingoa.
- Nō Pōneke ahau.
- Ko Maungakiekie taku maunga.
- Ko Waitematā taku moana.
- I te taha o taku matua, no Enniscorthy Ireland ahau.
- I te taha o aku whaea, no Cork Ireland ahau.
- Ko Tainui raua ko Ngapuhi nga iwi o nga mokopuna
- Tēnā koutou, Tēnā koutou, Tēnā tatou katoa.

THE WORKING GROUP

- An international ACM Innovation and Technology in Computer Science Education (ITiCSE) Conference working group
  - currently underway virtually and convening in July 2024:
- ***WG 2: A Multi-Institutional-Multi-National Study into the Impacts of AI on Work Practices of IT Professionals and Implications for Computing Students***
  - https://iticse.acm.org/2024/working-groups/#wg2

- *This coordinated, multinational working group is dedicated to examining the ramifications of AI integration within the IT sector.*
- *Employing qualitative research methods and conducting thematic analysis on interview data gathered from IT professionals [i.e. industry practitioners such as software developers] representing diverse contexts,*
- *the working group endeavours to uncover profound insights into how AI impacts work engagement, socio-technical dynamics, and the cultivation of professional competencies.*

Overview

- The concept of an ITiCSE working group
- Past working groups – history and context
- Progress of this working group
- Leaders & Rationale
- Members
- WG Steps taken so far
- Data Analysis Strategy
- Competencies
- Early insights?
- Implications for the teaching of software engineering ? - *tentative*

A Guide to ITiCSE Working Groups

Alison Clear & Tony Clear

[from presentation to ITiCSE 2016 Working Groups, Arequipa, Peru]

What is an ITiCSE Working Group?

A concept unique to the ITiCSE conference

A diverse group of people, different countries, different cultures, different institutions

Investigating an interesting, unresolved topic in Computer Science Education

How is a Working Group Proposed

Concept proposed in January and submitted to ITiCSE

Successful proposals published on the ITiCSE website

Interested people apply to join

Working Groups Work

Groups of 5 to around 10 participants work electronically prior to commencement of the conference

Work together face to face for the two days before the conference

Continue to work together for the duration of the conference

Working Groups Reports Publication

Produce a mature draft report on the last day of the conference

Rigorous cycle of blind reviewing

Final report published in the ACM digital library

Outcome

- Substantial research paper
- greater than 20 pages
- Breadth and depth
- Published as a set of proceedings in the ACM Digital Library
- Unique experience

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LERO Software for a better world

Historical Perspectives on the Computing Curriculum - Report of the ITiCSE'97 working group on Historical Perspectives in Computing Education

A Framework for Enhancing the Social Good in Computing Education: A Values Approach

Research Perspectives on the Objects-Early Debate

Naturally Occurring Data as Research Instrument: Analyzing Examination Responses to Study the Novice Programmer

Integrating cultural issues into the computer and information technology curriculum

Computing educators oral history project: seeking the trends

What's in a Name?: International Interpretations of Computing Education Terminology

Computing and sustainability: evaluating resources for educators

Comments from Working Group Chairs

- "A chance to really leverage resources that you can't do individually, gives you the ability to do a much wider search of the topic when you have 5-10 people together. A lot greater resources to tackle a topic"
- John Barr, July 2016

- "Builds a sense of trust"
- Tony Clear, July 2016

Comments from Working Group Chairs

- "Dynamic to be able to brainstorm to create and generate new ideas in person, just doesn't work on your own"
- "Don't have to be deep in a field, a great way to be initiated in the field and get up to speed quickly"
- "Get to meet people who have similar interests from all across the world"
- John Barr, July 2016

Comments from other WG participants

- Wonderful opportunity to meet new colleagues from around the world to meet on a problem of interest in CS Education
- Cary Laxer, July 2016
- One of the better community building ideas, f2f time with colleagues who have research interests in common
- Mats Daniels, Keynote speaker ITiCSE 2016

Planning the Work - Pre

- Think about preparatory activity
- Design and allocate tasks to members
- Design and prepare protocol, instruments questionnaires
- Arrange human subjects ethics protocols
- Collect examples
- Review selected literature
- Analyse data sets

Planning the Work - During

- Take stock of preparatory work completed
- Agree an agenda and plan
- Share contact details and conf. commitments
- Consider a draft structure for the report
- Work through ideas that require whole group input
- Divide the work and operate in parallel to produce the sections

Selected References

- [1] J. Noll, S. Beecham, and I. Richardson, "Global Software Development and Collaboration: Barriers and Solutions " *ACM Inroads,* vol. 1, no. 3, pp. 66-78, Sept 2010. [Online]. Available: http://doi.acm.org.ezproxy.aut.ac.nz/10.1145/1709424.1709428.
- [2] Clear, T., Beecham, S., Barr, J., Daniels, M., Mcdermott, R., Oudshoorn, M., Savickaite, A., and Noll, J., 2015. Challenges and Recommendations for the Design and Conduct of Global Software Engineering Courses: A Systematic Review. In ***Proceedings of the Working Group Reports of the 2015 on Innovation & Technology in Computer Science Education Conference***, N. Ragonis and P. Kinnunen Eds. ACM, New York, 1-39. DOI= http://dx.doi.org/http://dx.doi.org/10.1145/2858796.2858797.
- [3] Beecham, S., Clear, T., Barr, J. and Noll, J. Protocol for Challenges and Recommendations for the Design and Conduct of Global Software Engineering Courses: A Systematic Review, Limerick, Ireland 2015.
- [4] T. Clear, S. Beecham, J. Barr, M. Daniels, M. Oudshoorn, and J. Noll, "Developments in Global Software Engineering Education," in *46th ASEE/IEEE Frontiers in Education Conference.*, D. Trytten, H. Matusovich, and M. Castro Eds. Erie, PA: IEEE, 2016.
- [5] S. Beecham, T. Clear, J. Barr, M. Daniels, M. Oudshoorn, and J. Noll, "Preparing Tomorrow's Software Engineers for Work in a Global Environment," *IEEE Software,* vol. 34, no. 1, pp. 9-12, Jan/Feb 2017, doi: 10.1109/MS.2017.16.
- [6 S. Beecham, T. Clear, D. Damian, J. Barr, J. Noll, and W. Scacchi, "How Best to Teach Global Software Engineering? Educators Are Divided," *IEEE Software,* vol. 34, no. 1, pp. 16-19, Jan/Feb 2017, doi: 10.1109/MS.2017.12.
- [7] T. Clear and S. Beecham, "Global Software Engineering Education Practice Continuum Special Issue of the ACM Transactions on Computing Education," *ACM Transactions on Computing Education (TOCE),* vol. 19, no. 2, p. 7, 2019.
- [8] Clear, A., Clear, T., Vichare, A., Charles, T., Frezza, S., Gutica, M., Lunt, B., Maiorana, F., Pears, A. and Pitt, F. Designing Computer Science Competency Statements: A Process and Curriculum Model for the 21st Century in ***Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education***, ACM, New York, 2020.

Planning the Work – Pre 1

- Think about preparatory activity
  - Leaders initiated project and data collection [Sweden, UK, NZ]
  - MIMN design
- Design and allocate tasks to members
  - members selected – 15
  - countries and time zones
    - NZ [but on the move], Australia, Scotland, UK,
    - Norway, Sweden, US, Cyprus, Canada

Planning the Work – Pre 2

- Subgroups established – 4
  - Literature Review
  - Data Analysis
  - Practitioner Impacts
  - Competencies
  - Spreads the work and the time zone diffs.
- Design and prepare protocol, instruments questionnaires
- Arrange human subjects ethics protocols
- – leaders completed, separately by institution
- – Data sharing agreement developed

Planning the Work – Pre 3

- Collect examples
  - in country interviews under way
  - zoom and automatic transcription and translation service - (GDPR certified) - Sweden
  - MS -Teams and auto transcription – NZ
  - Zoom and manual transcription by exception
  - Interviews on the move, time zones and B&B wifi!
  - Getting buy-in
  - Information Sheets, consent forms
  - Semi-structured interviews common schedule

Planning the Work – Pre 4

- Review selected literature
  - subgroup allocated
  - Some subgroup specific literature searches
- Analyse data sets
  - subgroup allocated
  - secure central repository established [UU - ALLVIS]
  - common data sharing agreement established
  - draft data analysis protocol developed

Data Analysis Protocol - Options

- Reviewing Options
- literature on protocol templates has been consulted (Brereton et al., 2008; King et al., 2018; Stol and Fitzgerald, 2014).
- The excerpt below from Brereton et al., (2008), although positioned at the **overall case study level**, makes some highly relevant points:
- 1) no existing data analysis template was found to be available,
- 2) the two phases of "*creating instruments and protocols*" and "*analysing data*" - see over - were considered most applicable for this protocol.

- Brereton, P., Kitchenham, B., Budgen, D., & Li, Z. (2008). Using a protocol template for case study planning. Proceedings of the 12th international conference on Evaluation and Assessment in Software Engineering,
- King, N., Brooks, J., & Tabari, S. (2018). Template analysis in business and management research. *Qualitative methodologies in Organization studies: volume II: methods and possibilities*, 179-206.
- Stol, K.-J., & Fitzgerald, B. (2014). *Research protocol for a case study of crowdsourcing software development* (Lero Technical Report -TR_2014_03). https://cora.ucc.ie/handle/10468/7039

Developing a Data Analysis Protocol

- Full Case Study Protocol
- *"Eisenhardt (1989) concerned with using case studies to develop theories suggests the following activities:*

  - ***Getting started*** *by defining the research question and a priori questions but not defining hypotheses or theory.*
  - ***Selecting cases*** *by considering a particular population and using theoretical concerns to focus on specific cases.*
  - ***Crafting instruments and protocols*** *using multiple data collection methods, using qualitative and quantitative data, and preferably multiple researchers.*
  - ***Entering the field*** *i.e. incorporating field notes with data analyses and using flexible and opportunistic data collection methods.*
  - ***Analysing the data*** *both within case and across cases.*
  - ***Shaping hypotheses*** *by iterative tabulation of evidence looking for identified constructs, replication logic across cases, and looking for evidence to explain why relationships exist.*
  - ***Enfolding the literature*** *i.e. comparing with existing similar and conflicting literature.*
  - ***Reaching closure*** *using the concept of "theoretical saturation" which says researchers stop looking for more cases/data when they believe more data will only give a marginal improvement to the existing results". (Brereton et al., 2008)*

Forms of Template Analysis

- King et al., (2018) presenting "*Template Analysis*" :
- "*Thematic analysis is widely acknowledged as an accessible and useful approach to the analysis of rich and meaningful qualitative data—indeed, Clarke and Braun (2013) describe thematic analysis as the 'basic' method of qualitative data analysis".*
- *Template Analysis a particular style of thematic analysis*
- distinguish between *Generic Template Analysis* as a *method*, and as applied within a broader research *methodology* such as grounded theory or Interpretative Phenomenological Analysis [IPA],
- observe that issues about differing philosophical, theoretical or methodological positions can be better accommodated, as noted below:
- *Generic styles of thematic analysis can provide researchers more flexibility and adaptability to the particular requirements of their own work—rather than applying a methodology as a whole package.*

Steps in Template Analysis

- In template analysis the general steps in the process are defined by King et al., (2018) as below:
- *procedural steps characteristically followed in Template Analysis are:*
  - • *Familiarization with the data*
  - • *Preliminary coding*
  - • *Clustering*
  - • *Developing the initial template*
  - • *Modifying the template*
  - • *Defining the 'final' template*
  - • *Using the template to interpret the data*
  - • *Writing-up*
-

WG Data Analysis Subgroup

- data analysis sub-group will conduct the three steps prior to developing the initial template "*Familiarization with the data, preliminary coding, clustering*", using a subset of the transcript data, to derive an initial template using a defined spreadsheet for coding each transcript.
- The template will be refined as the process progresses as noted by *(King et al., 2018):*
  - *Revisions might include: re-defining themes to increase or narrow their scope (shown through moving them up or down hierarchical levels), moving themes between clusters, adding new themes—or even entire new clusters—and deleting themes that have become redundant as the template has developed.*
- Version one of the template allows for coding of each question.
- For some questions a predefined set of deductive codes as an initial set of codes for that question,
- for other questions a more inductive strategy may be more suitable.

WG Analysis - Work Allocation

- Decisions about coding parties need to be made.
- It is presumed at this stage that work will be distributed amongst the WG members to share the load, once the template is sufficiently stable.
- Members of the WG will generally code whole transcripts, possibly adopting a pair coding strategy, first individually coded then by comparison between pairs.
- But it may be preferable to assign questions to sub-groups, e.g. question 4.3 by the competencies sub-group?
-
- The transcripts will be stored in the Uppsala ALLVIS repository, and made available to members whose institutions have signed the data sharing agreement.

Planning the Work – During the WG Mtg

Partly In Progress

- Take stock of preparatory work completed
- Agree an agenda and plan
- Share contact details and conf. commitments
- Consider a draft structure for the report
- Work through ideas that require whole group input
- Divide the work and operate in parallel to produce the sections

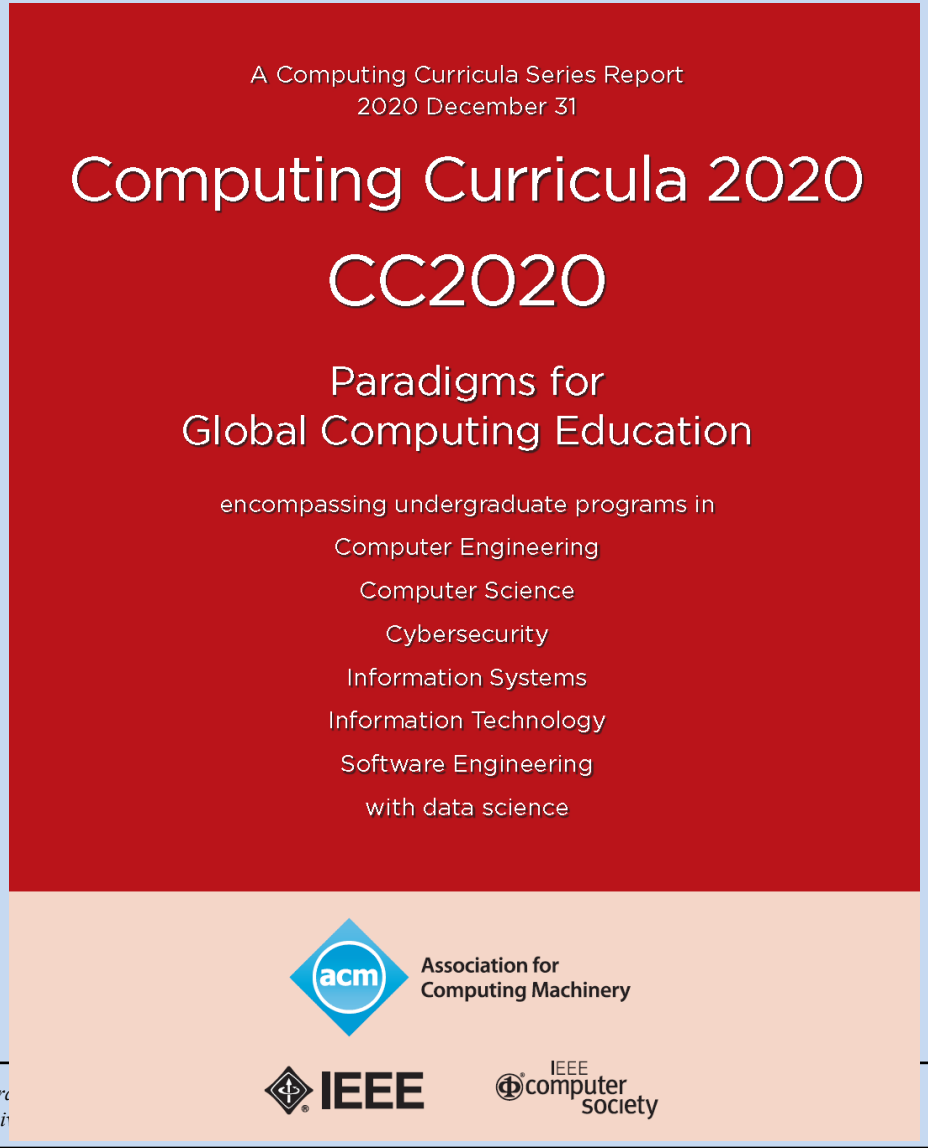
Planning the Work – During -2 TBD

- Allocate a paper editor
- Review components and drafts as they come in
- Prepare for presentation day one of conference
  - Update audience on topic & progress
  - Seek feedback in selected areas
- Build consensus towards a final draft
- Produce consolidated mature draft and handover to WG Chairs on the last day of the conference before leaving
- Advise a list of three sound reviewers

Planning the Work – Post TBD

- Ensure responsibility allocated for final draft
- Share timetables [holidays and semester commitments]
- Work on final draft [version tracking mechanism in place] and share amongst whole or core team
- Submit and wait for reviews
- Make changes as advised by reviewers
- Submit camera ready copy and hope!

CC2020 Project Curriculum Directions



Clear, A., Parrish, A., & CC2020 Task Force. (2020). *Computing Curricula 2020 - CC2020 – Paradigms for Future Computing Curricula* Retrieved from New York:

https://www.acm.org/binaries/content/assets/education/curricula-recommendations/cc2020.pdf

A Framework for Structuring Competency Related Responses?

CC2020 Project Model

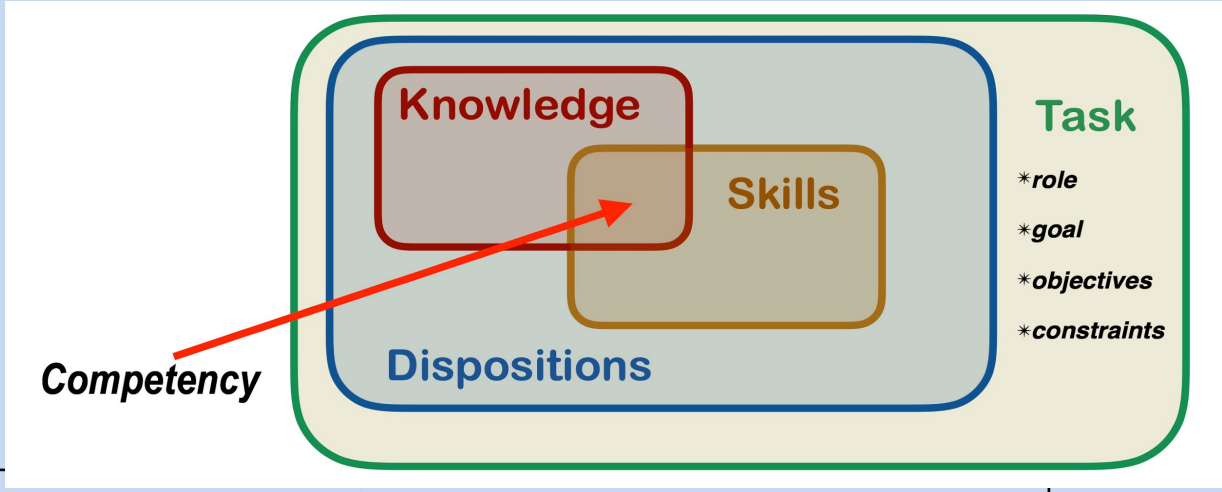
Aspects of knowledge based learning [Established Curriculum Paradigm]

- KA's [knowledge areas]
- KU's [knowledge units]
- LO's [Learning outcomes]

Components of competency based learning [CC2020 Model]

- **Competency = [Knowledge+ Skills+ Dispositions] in Task**

- A competency structure (see Fig. 1) shows knowledge, skills, and dispositions that are observable in the accomplishment of a task, a task that prescribes purpose within a work context [24].



CC2020 – COMPETENCY BASED LEARNING

- *Knowledge* is the "*know-what*" dimension of competency that is factual.
- *Skills* express the "*know-how*" and usually develop over time and with practice.
- *Dispositions* frame the "*know-why*" dimension of competency, which prescribes a requisite character or quality in task performance.
- *Task* is the construct that frames the skilled application of knowledge and makes dispositions concrete.

SUBJECT/CONTENT KNOWLEDGE

3.2.1 Knowledge Vocabulary for Computer Science Competencies. The CS2013 document divides computer science knowledge into 18 KAs subdivided into 225 KUs. For example, the Software Engineering KA is divided into ten KUs:

(1) SE/Software Processes
(2) SE/Software Project Management
(3) SE/Tools and Environments
(4) SE/Requirements Engineering
(5) SE/Software Design
(6) SE/Software Construction
(7) SE/Software Verification and Validation
(8) SE/Software Evolution
(9) SE/Software Reliability
(10) SE/Formal Methods

Clear, A., Clear, T., Vichare, A., Charles, T., Frezza, S., Gutica, M., . . . Pitt, F. (2020). Designing Computer Science Competency Statements: A Process and Curriculum Model for the 21st Century In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education*. New York: ACM.

PROFESSIONAL & FOUNDATIONAL KNOWLEDGE

Table 4: Professional & Foundational Knowledge Areas extending CS2013

Tag	Knowledge Area
PK-1	Oral Communication & Presentation
PK-2	Written Communication
PK-3	Problem Solving and Trouble Shooting
PK-4	Project/Task Organization & Planning
PK-5	Collaboration and Teamwork
PK-6	Research and Self-Learning
PK-7	Multi-Task Prioritization & Management
PK-8	Relationship Management
PK-9	Analytical and Critical Thinking
PK-10	Time Management
PK-11	Quality Assurance / Control
PK-12	Mathematics and Statistics
PK-13	Ethical Intercultural Perspectives

Clear, A., Clear, T., Vichare, A., Charles, T., Frezza, S., Gutica, M., . . . Pitt, F. (2020). Designing Computer Science Competency Statements: A Process and Curriculum Model for the 21st Century In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education*. New York: ACM.

SKILLS

Table 4.3. Levels of Cognitive Skills Based on Bloom's Taxonomy

Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Exhibit memory of previously learned materials by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, and giving descriptions.	Solve problems in new situations by applying acquired knowledge, facts, techniques, and rules in a different way.	Examine and break information into parts by identifying motives or causes; make inferences and find evidence to support solutions.	Present and defend opinions by making judgments about information, validity of ideas, or quality of material.	Compile information together in a different way by combining elements in a new pattern or by proposing alternative solutions.

Clear, A., Parrish, A., & CC2020 Task Force. (2020). *Computing Curricula 2020 - CC2020 – Paradigms for Future Computing Curricula* Retrieved from New York: https://www.acm.org/binaries/content/assets/education/curricula-recommendations/cc2020.pdf

CC2020 DISPOSITIONS

Table 6: CC2020 Disposition Vocabulary

Label	Disposition	Elaboration [25]
D-1	Proactive	*With Initiative / Self-Starter.* Shows independence. Ability to assess and start activities independently without needing to be told what to do. Willing to take the lead, not waiting for others to start activities or wait for instructions.
D-2	Self-Directed	*Self-motivated / Self-Directed.* Demonstrates determination to sustain efforts to continue tasks. Direction from others is not required to continue a task toward its desired ends.
D-3	Passionate	*With Passion / Conviction.* Strongly committed to and enthusiastic about the realization of the task or goal. Makes the compelling case for the success and benefits of task, project, team or means of achieving goals.
D-4	Purpose-Driven	*Purposefully engaged / Purposefulness.* Goal-directed, intentionally acting and committed to achieve organizational and project goals. Reflects an attitude towards the organizational goals served by decisions, work or work products. E.g., business acumen.
D-5	Professional	*With Professionalism / Work ethic.* Reflects qualities connected with trained and skilled people: acting honestly, with integrity, commitment, determination and dedication to what is required to achieve a task.
D-6	Responsible	*With Judgement / Discretion / Responsible / Rectitude.* Reflects on conditions and concerns, then acts according to what is appropriate to the situation. Makes responsible assessments and takes actions using professional knowledge, experience, understanding and common sense. E.g., Responsibility, Professional astuteness.
D-7	Adaptable	*Adaptable / Flexible / Agile.* Ability or willingness to adjust approach in response to changing conditions or needs.
D-8	Collaborative	*Collaborative / Team Player / Influencing.* Willingness to work with others; engages appropriate involvement of other persons and organizations helpful to the task; strives to be respectful and productive in achieving a common goal.
D-9	Responsive	*Responsive / Respectful.* Reacts quickly and positively. Respects the timing needs for communication and actions needed to achieve the goals of the work.
D-10	Meticulous	*Attentive to Detail.* Achieves thoroughness and accuracy when accomplishing a task through concern for relevant details.
D-11	Inventive	*Exploratory / Inventive.* Looks beyond simple solutions; examines alternative ideas and solutions; seeks, produces and integrates appropriate alternative.

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Specifying Competencies?

KA-Ref#	Title	Competency Statement	Dispositions	Knowledge-Skill Pairs				Traced Competencies	Notes
				KU / Broader Knowledge Description	Topic/LO Description	Knowledge Element	Paired Skill Level		
Our reference number goes here. E.g., "KA-##"	Short Title	Competency statement goes here (Natural Language) that embeds the task/context and suggests the K-S-D breadth and depth	List top applicable dispositions: <ID+descriptor>. Note that dispositions are not aligned with KS-pairs.	CS2013 or other description of a KU	Text of LO or Topic or Professional Skill	CS2013 LO or Topic ID	Bloom's Level	List other competency reference #s that this competency expects or depends upon. Often null.	Any notes or comments
					Text of LO or Topic or Professional Skill	CS2013 LO or Topic ID	Bloom's Level		Often null
					Text of LO or Topic or Professional Skill	CS2013 LO or Topic ID	Bloom's Level		
				CS2013 or other description of a KU	Text of LO or Topic or Professional Skill	New IDs for extensions to CS2013	Bloom's Level		Note deviations from Bloom's level in CS2013
					Text of LO or Topic or Professional Skill	CS2013 LO or Topic ID	Bloom's Level		

Figure 5: Competency specification in a tabular format

Clear, A., Clear, T., Vichare, A., Charles, T., Frezza, S., Gutica, M., . . . Pitt, F. (2020). Designing Computer Science Competency Statements: A Process and Curriculum Model for the 21st Century In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education*. New York: ACM.

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EXPRESSING COMPETENCIES?

"…most appropriate to express competencies at the level of entire KAs, **from the point of view of a graduate or professional**.

When we "designed" a competency statement, we focused on a particular knowledge area and **looked for collections of topics and/or learning outcomes (LOs) that could be observed in tasks and at particular skill levels.**

…there was significant variance in how this was approached, and how the resulting competency was formulated. **Dispositions were often implied at first, but refinement of the statements made these both more clear and more relevant**."

Clear, A., Clear, T., Vichare, A., Charles, T., Frezza, S., Gutica, M., . . . Pitt, F. (2020). Designing Computer Science Competency Statements: A Process and Curriculum Model for the 21st Century In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education*. New York: ACM.

A Sample Competency Statement

Table 7: IS-4: IS/Basic Machine Learning

Statement	Dispositions
Confidently apply relevant statistical techniques to differing modes of machine learning when undertaking an assigned classifying task, and show the ability to precisely measure the accuracy of the resulting classifier.	D-6 (Responsible) D-10 (Meticulous)

Clear, A., Clear, T., Vichare, A., Charles, T., Frezza, S., Gutica, M., . . . Pitt, F. (2020). Designing Computer Science Competency Statements: A Process and Curriculum Model for the 21st Century In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education*. New York: ACM.

STATEMENT IN FULL

Table 7: IS-4: IS/Basic Machine Learning

Statement				Dispositions
Confidently apply relevant statistical techniques to differing modes of machine learning when undertaking an assigned classifying task, and show the ability to precisely measure the accuracy of the resulting classifier.				D-6 (Responsible) D-10 (Meticulous)
Knowledge Unit	**Topic/LO Description**	**Knowledge Element**	**Skill Level**	**Notes**
IS/Basic Machine Learning	List the differences among the three main styles of learning: supervised, reinforcement, and unsupervised.	IS-BML-1	B-II	
	Identify examples of classification tasks, including the available input features and output to be predicted	IS-BML-2	B-II	
	Explain the difference between inductive and deductive learning	IS-BML-3	B-II	
	Describe over-fitting in the context of a problem	IS-BML-4	B-II	
	Apply the simple statistical learning algorithm such as Naive Bayesian Classifier to a classification task and measure the classifier's accuracy	IS-BML-5	B-III	
Prof. & Foundational Knowledge	Analytical and Critical Thinking	PK-9	B-III	
	Mathematics and Statistics	PK-12	B-III	
IS/Basic Machine Learning	Definition and examples of broad variety of machine learning tasks, including classification	IS-BML-a	B-II	
	Inductive Learning	IS-BML-b	B-II	
	Simple statistical-based learning, such as Naive Bayesian Classifier, decision trees	IS-BML-c	B-III	
	The over-fitting problem	IS-BML-d	B-II	
	Measuring classifier accuracy	IS-BML-e	B-III	

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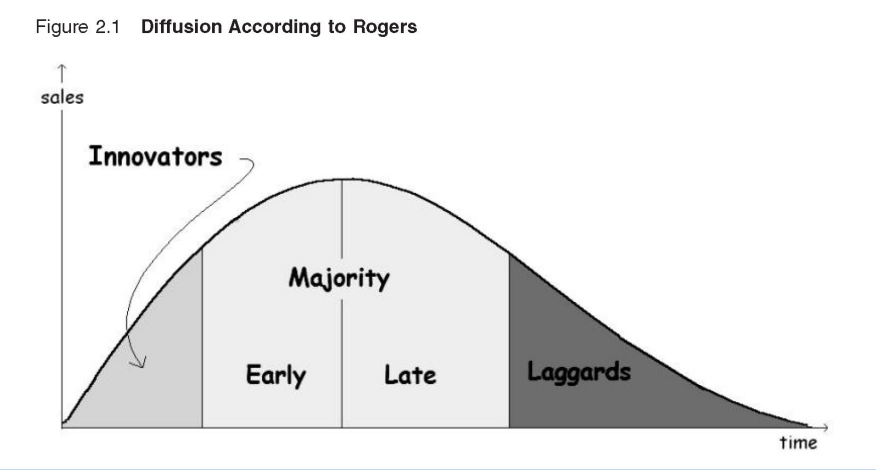
Early WG insights?

- Seems to be early days yet?
- Variable acceptance and adoption
- Outright ban to enthusiastic incorporation in ways of working



Libai, B., Mahajan, V., & Muller, E. (2017). Can you see the chasm?: Innovation diffusion according to rogers, bass, and moore. In *Review of marketing research* (pp. 38-57). Routledge.

- Active experimentation – personal and institutional pilot studies - FOMO
- Some vendor guided adoptions e.g. Microsoft and Copilot [Copilot not an Auto-pilot]
- Large Corporate risk assessment before a standard approach adopted

Implications for teaching SE 1?

- A shift to a dialogic model of interacting with systems
- Prompt Engineering and refinement of strategies
- API's to connect with backend chatbots easily implemented [e.g. Vercel https://vercel.com/changelog/next-js-ai-chatbot-2-0]
- Good reviews:
  - Ebert, C., & Louridas, P. (2023). Generative AI for software practitioners. *IEEE Software, 40*(4), 30-38.
  - Ozkaya, I. (2023). Application of Large Language Models to Software Engineering Tasks: Opportunities, Risks, and Implications. *IEEE Software*, 40(3), 4-8. https://doi.org/10.1109/MS.2023.3248401
- What to do about various forms of cheating?
- How to shift to acceptable and valuable behaviour

Implications for teaching SE 2?

- What to do about various forms of cheating?
- How to shift to acceptable and valuable behaviour
- Just today's 4GL and end-user development fad?
- How to develop judgement and handling reviews and errors
- Hallucinations an inherent design of LLM technology?
- How to co-exist with Gen-AI services?
- How to redesign courses and assessments?

Implications for teaching SE 3?

- Commercial services and downsides
- Cost and accessibility issues?
- What to do about various forms of cheating?
- Observed violations of service agreements – who reports miscreants?
- Privacy and IP rights
- Whose work and evolving citation standards?
- AI systems and embedded biases
- Ethical awareness

ACADEMIC INTEGRITY - THEN?

https://canvas.aut.ac.nz/courses/7624/pages/referencing 9/01/2023 - and evolving

You **can** use AI when writing or preparing a presentation if you use it to help you improve small aspects of your work, such as:

- grammar and punctuation, and
- formal terminology.

You **cannot** use AI to generate ideas when writing, preparing a presentation or creating an artwork/artefact (unless otherwise specified in your assessment instructions). The ideas have to come from you and your course materials.

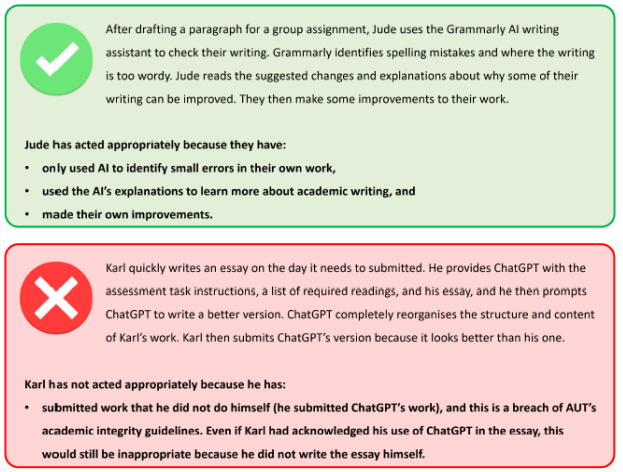


Figure 4: Appropriate and inappropriate uses of AI when writing and presenting

Reference

AAIN Generative AI Working Group. (2023). *AAIN Generative Artificial Intelligence Guidelines, Australian Academic Integrity Network*. https://doi.org/10.26187/sbwr-kq49 (https://doi.org/10.26187/sbwr-kq49)

Academic integrity - now?

https://canvas.aut.ac.nz/courses/7624/pages/academic-integrity 10/05/2024 - and evolving

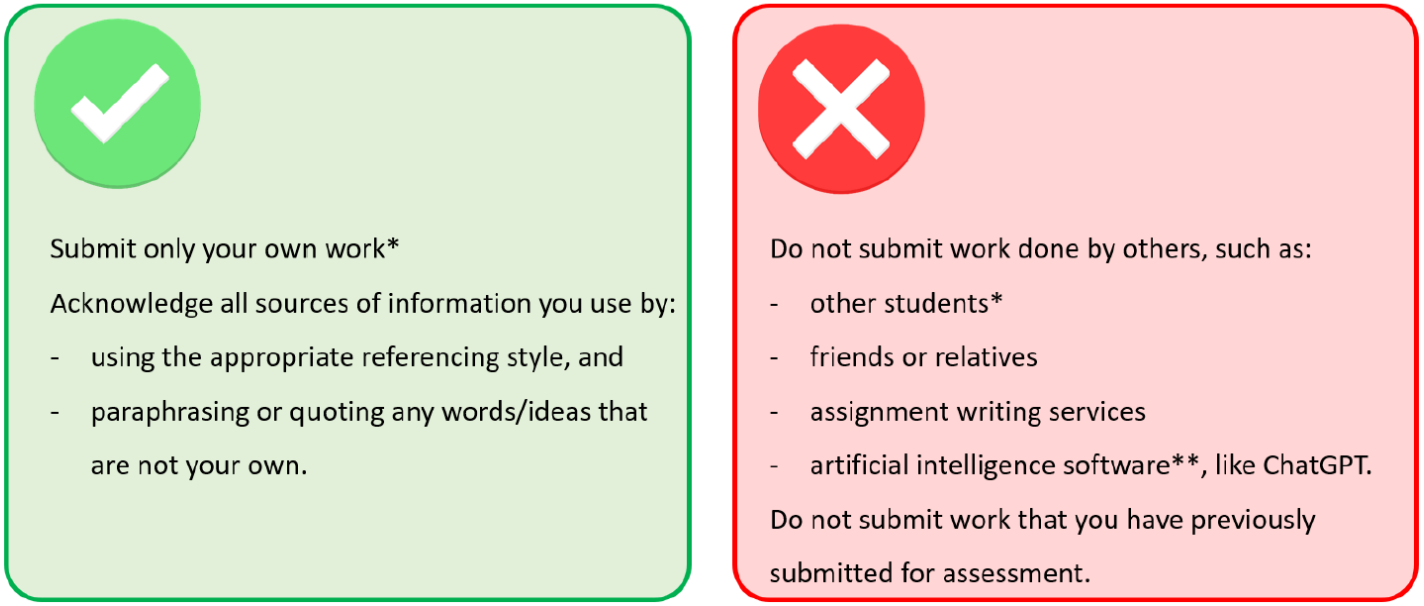


Figure 1: How to maintain academic integrity

* Unless the work is for a designated (group) task

** If your assessment requires the approved use of artificial intelligence, you must acknowledge wherever you do so in your work with an appropriate in-text reference (see guidelines for APA (https://aut.ac.nz.libguides.com/APA7th/software#s-lg-box-22369312), Chicago (https://aut.ac.nz.libguides.com/turabian/personalcomms#s-lg-box-22370438), and Harvard (https://aut.ac.nz.libguides.com/c.php?g=919289&p=6648988#s-lg-box-22370440) referencing styles).

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TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

ACADEMIC INTEGRITY – NOW?

Artificial intelligence software

Referencing the information generated by an algorithm or artificial intelligence software tool, such as ChatGPT.

Credit the author of the algorithm/AI tool with a reference list entry and an in-text citation.

Reference list format

Who	When	What	Where
Author of AI tool.	(Year released).	*Title of tool* (Version) [Description].	URL to access tool

Reference list example

OpenAI. (2023). *ChatGPT* (Mar 14 version) [Large language model]. https://chat.openai.com/chat

In-text citation examples

OpenAI (2023) generated the following response when...

...that indicates a limitation of the software (OpenAI, 2023).

In your writing

- Describe how you used the tool.
- Provide the prompt you used.
- Provide any portion of the relevant text that was generated in response.
- Document the exact text created because tools like ChatGPT generate unique responses in each chat session, even if given the same prompt.

More information

Software for a better world

https://aut.ac.nz.libguides.com/APA7th/software#s-lg-box-22369312

https://apastyle.apa.org/blog/how-to-cite-chatgpt

ChatGPT – Terms of Use

What you can do. Subject to your compliance with these Terms, you may access and use our Services.
In using our Services, you must comply with all applicable laws as well as our Sharing & Publication Policy, Usage Policies, and any other documentation, guidelines, or policies we make available to you.

What you cannot do. You may not use our Services for any illegal, harmful, or abusive activity. For example, you may not:

- Use our Services in a way that infringes, misappropriates or violates anyone's rights.
- …
- Represent that Output was human-generated when it was not.
- ….
- Use Output to develop models that compete with OpenAI.

OpenAI. (2024, January 31 2024). *Terms of Use*. Retrieved 10/05/2024 from https://openai.com/policies/terms-of-use

ChatGPT – Terms of Use

Your content. You may provide input to the Services ("Input"), and receive output from the Services based on the Input ("Output"). Input and Output are collectively "Content."

"Content." You are responsible for Content, including ensuring that it does not violate any applicable law or these Terms. You represent and warrant that you have all rights, licenses, and permissions needed to provide Input to our Services.

Our use of content. We may use Content to provide, maintain, develop, and improve our Services, comply with applicable law, enforce our terms and policies, and keep our Services safe.

Opt out. If you do not want us to use your Content to train our models, you can opt out by following the instructions in this Help Center article. Please note that in some cases this may limit the ability of our Services to better address your specific use case.

OpenAI. (2024, January 31 2024). *Terms of Use*. Retrieved 10/05/2024 from https://openai.com/policies/terms-of-use

Broader Implications

- Giving data into the datacube of the BORG!
- By Tomás Del Coro from Las Vegas, Nevada, USA - Trekkie - Borg - Star Trek Convention, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=58277452

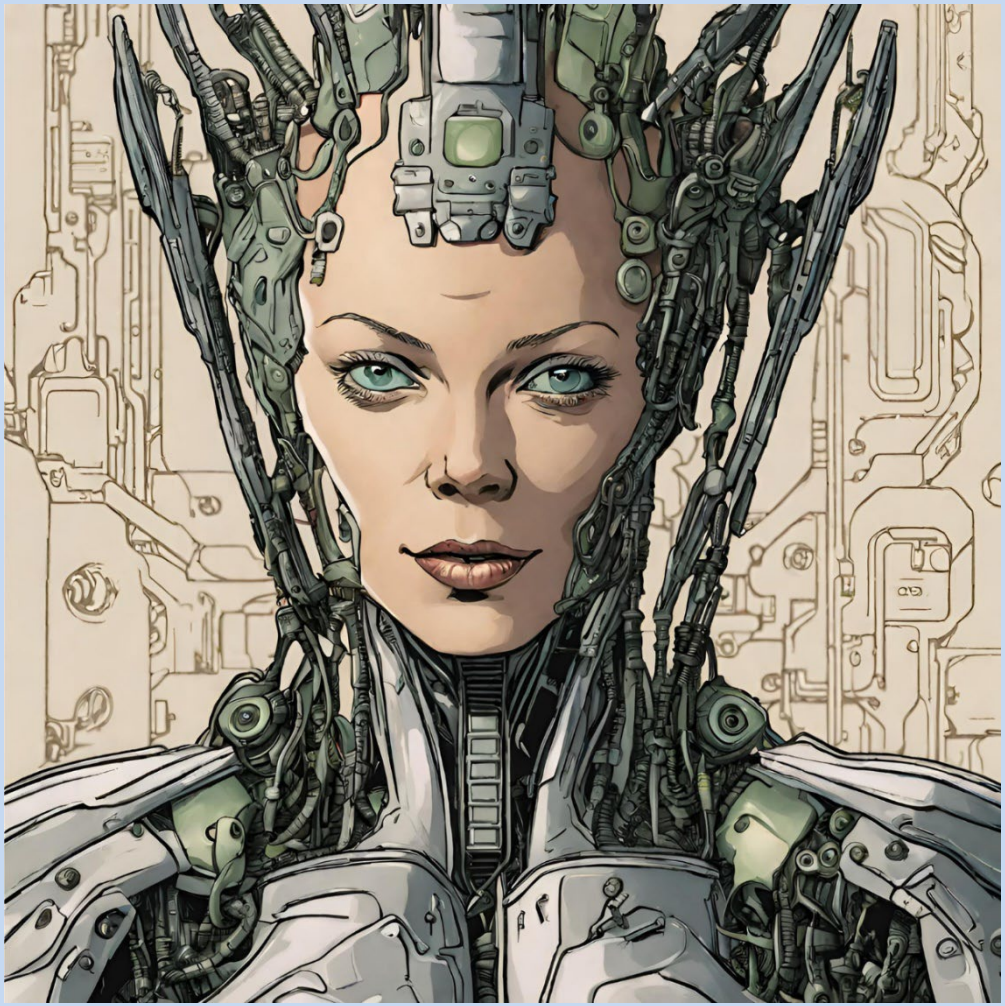
IMPLICATIONS?

- Giving data into the maw of the BORG!

- By Tomás Del Coro from Las Vegas, Nevada, USA - Trekkie - Borg - Star Trek Convention, CC BY-SA 2.0, https://upload.wikimedia.org/wikipedia/commons/5/52/Trekkie_-_Borg_-_Star_Trek_Convention_%289504912575%29.jpg

Implications for teaching SE?

- Giving data into the clutches of the BORG and Getting it Back?



https://www.mediawiki.org/wiki/File:Borg_Queen_by_Canva_AI.png

Polski: Artystyczny wizerunek królowej Borg z uniwersum Star trek wygenerowany przez oprogramowanie Canva Magic Multimedia
English: Borg Queen from Star Trek universe artistic vision generated by Canva Magic Multimedia

4 April 2024

Own work

Canva Magic Multimedia

CONCLUSION

- Covered ITiCSE working groups and this one
  - *Implications of [Gen] AI for IT professionals and competencies*
- Covered WG creation and progress to date
- Outlined Data Analysis Strategy and Protocol
- Defined Competencies from a CC2020 perspective
- Discussed early insights about the state of the art?
- Explored tentative implications for the teaching of software engineering ?
- Still early work
- To be fleshed out in the final report [after WG meets 4 – 7 July and revisions by end of year - all going well ☺]

Generative AI and its Implications for Competencies: Work in Progress

Questions?

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Auckland University of Technology

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Planning the Work – During -2

- Allocate a paper editor
- Review components and drafts as they come in
- Prepare for presentation day one of conference
  - Update audience on topic & progress
  - Seek feedback in selected areas
- Build consensus towards a final draft
- Produce consolidated mature draft and handover to WG Chairs on the last day of the conference before leaving
- Advise a list of three sound reviewers

Planning the Work - Post

- Ensure responsibility allocated for final draft
- Share timetables [holidays and semester commitments]
- Work on final draft [version tracking mechanism in place] and share amongst whole or core team
- Submit and wait for reviews
- Make changes as advised by reviewers
- Submit camera ready copy and hope!

Defining & Describing Skills

Table 5: Sample CC2020 Skill Level Vocabulary [3]

	I Remembering	II Understanding	III Applying	IV Analyzing	V Evaluating	VI Creating
Definitions	Exhibit memory of previously learned materials…	Demonstrate understanding of facts and ideas…	Solve problems in new situations by applying…	Examine and break information into parts…	Present and defend opinions by making judgments about information…	Compile information together in a new way…
Verbs	Choose, define, find, how, label, list, match, name, omit, recall, relate, select, show, spell, tell, what, when, where, which, who, why	Classify, compare, contrast, demonstrate, explain, extend, illustrate, infer, interpret, outline, relate, rephrase, show, summarize, translate	Apply, build, choose, construct, develop, experiment with, identify, interview, make use of, model, organize, plan, select, solve, utilize	Analyze, assume, categorize, classify, compare, contrast, discover, dissect, distinguish, divide, examine, function, infer, inspect, list, relate, simplify, survey, take part in, test for	Agree, appraise, assess, award, choose, conclude, criteria, criticize, decide, deduct, defend, determine, disprove, estimate, evaluate, explain, interpret, judge, justify, measure, prioritize, prove, rate, recommend, select	Adapt, build, change, combine, compose, construct, create, design, develop, elaborate, estimate, improve, invent, make up, maximize, minimize, modify, optimize, originate, plan, predict, propose solution, solve, test theory

Clear, A., Clear, T., Vichare, A., Charles, T., Frezza, S., Gutica, M., . . . Pitt, F. (2020). Designing Computer Science Competency Statements: A Process and Curriculum Model for the 21st Century In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education*. New York: ACM.

On teaching dispositions?

- in discussing whether dispositions could be taught [Clear, 2021], I noted that *"... a disposition "concerns not what abilities people have,* ***but how people are disposed to use those abilities****" [Schussler, 2006].*

  So here we are talking about a mindset and attitudinal dimensions, which raises the question can a disposition be taught or is it some innate part of a person's character?"

  [Clear, 2021]

Clear, T. (2021). THINKING ISSUES: Is Agility a Disposition and Can it be Taught? . *ACM Inroads, 12*(1), 13-14. doi:10.1145/3447870

CC2020 DISPOSITIONS

Table 6: CC2020 Disposition Vocabulary

Label	Disposition	Elaboration [25]
D-1	Proactive	*With Initiative / Self-Starter.* Shows independence. Ability to assess and start activities independently without needing to be told what to do. Willing to take the lead, not waiting for others to start activities or wait for instructions.
D-2	Self-Directed	*Self-motivated / Self-Directed.* Demonstrates determination to sustain efforts to continue tasks. Direction from others is not required to continue a task toward its desired ends.
D-3	Passionate	*With Passion / Conviction.* Strongly committed to and enthusiastic about the realization of the task or goal. Makes the compelling case for the success and benefits of task, project, team or means of achieving goals.
D-4	Purpose-Driven	*Purposefully engaged / Purposefulness.* Goal-directed, intentionally acting and committed to achieve organizational and project goals. Reflects an attitude towards the organizational goals served by decisions, work or work products. E.g., business acumen.
D-5	Professional	*With Professionalism / Work ethic.* Reflects qualities connected with trained and skilled people: acting honestly, with integrity, commitment, determination and dedication to what is required to achieve a task.
D-6	Responsible	*With Judgement / Discretion / Responsible / Rectitude.* Reflects on conditions and concerns, then acts according to what is appropriate to the situation. Makes responsible assessments and takes actions using professional knowledge, experience, understanding and common sense. E.g., Responsibility, Professional astuteness.
D-7	Adaptable	*Adaptable / Flexible / Agile.* Ability or willingness to adjust approach in response to changing conditions or needs.
D-8	Collaborative	*Collaborative / Team Player / Influencing.* Willingness to work with others; engages appropriate involvement of other persons and organizations helpful to the task; strives to be respectful and productive in achieving a common goal.
D-9	Responsive	*Responsive / Respectful.* Reacts quickly and positively. Respects the timing needs for communication and actions needed to achieve the goals of the work.
D-10	Meticulous	*Attentive to Detail.* Achieves thoroughness and accuracy when accomplishing a task through concern for relevant details.
D-11	Inventive	*Exploratory / Inventive.* Looks beyond simple solutions; examines alternative ideas and solutions; seeks, produces and integrates appropriate alternative.

Clear, A., Clear, T., Vichare, A., Charles, T., Frezza, S., Gutica, M., . . . Pitt, F. (2020). Designing Computer Science Competency Statements: A Process and Curriculum Model for the 21st Century In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education*. New York: ACM.