Visual representation of the mismatch between industry skills demand and higher education skills supply

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Aligning the skills addressed by higher education to the demands of industry is an ongoing challenge. This paper describes the rationale for developing and using a visualization application to highlight the skills demand and skills supply mismatch between work-integrated learning (WIL) stakeholders. The objective was to develop a minimal viable product (MVP) to be utilized as a visualization application. Visualization allows for the data to be structured in an organized way for comparison and pattern identification. Participatory action research informed the development of a MVP, referred to as a skills hub. This paper reports how the skills hub visualizes the skills mismatch through collaboration between participating higher education institutions, a multi-national financial institution, skills assessment partner, and a consulting partner. The research result is that WIL stakeholders benefit from the skills hub as an application that provides a visualization process to translate skills shared in the process of knowledge exchange.

Keywords: Skills mismatch, collaboration, visualization, minimal viable product, knowledge exchange partners

This paper describes the rationale for using visualization to highlight the skills demand and supply mismatch which exists between Higher Education Institutions (HEIs) and industry. The importance of eradicating the skills mismatch has been a topic of discussion by the World Economic Forum (WEF, 2016). Although WIL discussions and initiatives enhance collaboration between HEIs and industry, some WIL stakeholders have competing understandings of graduate attributes (Ferguson et al., 2021; Rook & Sloan, 2021). Despite many WIL discussions and processes, the outcomes of these collaborative engagements cannot be easily retrieved from a single platform, because it is recorded under various sources and stored by different stakeholders (Brink et al., 2014). A tool which enables the visualization of the skills mismatch is useful for validating successful WIL outcomes.

The skills mismatch topic is complex in nature; its roots are discipline-, geographic-, socio-, and institution-based, and caused by structural inequities, systemic barriers, type of knowledge, and other risk factors (Adely et al., 2012; Hodges & Burchell, 2003; Itano-Boase et al., 2021). The central argument of this paper is that through visualization, WIL stakeholders can acquire insights regarding the skills gap which exists between HEI and industry, cultivate a better understanding, and value new knowledge with minimal narrative (Verdinelli & Scagnoli, 2013). To further advance WIL practice, Rowe et al. (2022) recommend co-creating the WIL curriculum, which requires the involvement and collaboration of all stakeholders. This paper reports the development of a visualization application to aid WIL stakeholders. It is important to explore technology solutions such as a visualization application for upscaling WIL practices. WIL practice should explore remote opportunities and investigate all avenues to support the sustainability of WIL (Rowe et al., 2022).

WIL researchers apply theories and processes such as constructive alignment, triangulation, social connectedness, mutual trust, scaffolding, and knowledge exchange to inform and evaluate work

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placement (Choy & Sappa, 2021; Tezcan et al., 2020; Von Treuer et al., 2011). The conceptualization of the process of developing a visualization application was informed by the theories of Batatia et al. (2012), and Biggs (2014), as follows:

- Constructive alignment is an approach to evaluate learning, which begins with the idea that the learner constructs his or her learning through relevant activities (Biggs, 2014). Visualizing the skills supplied through learning versus the skills in demand by industry, would highlight the skills alignment or lack thereof to WIL stakeholders between what graduates have attained through their learning versus the expected work readiness outcome by industry.
- The skills shared by participating HEIs and industry partners through collaboration is based on the trialogical process of collaboration between participants (Batatia et al., 2012).

The results of skills in demand versus skills in supply shared during a collaborative effort between WIL stakeholders via a central platform or skills hub, can be presented through visual images. Visual images would clearly highlight the relationship between skills in demand and skills supplied. A visualization application is required to create visual images.

VISUALIZATION APPLICATION

Careful consideration must be applied in the selection of the most appropriate visualization method to reflect the skills mismatch or skills alignment between HEIs and industry. For example, WIL stakeholders may have different views of so-called soft skills and hard skills within their workplace settings. An outline of terminology for the development of a visualization application must be established, for example, hard skills and soft skills and visualization of skills.

Skills

Skills can be obtained through various life experiences such as knowledge and abilities acquired within a person's sociocultural environment, modelled after caregivers and role models from the community, cognitively adopted through education, influenced by origin, determined by location, and obtained by deconstructing the reality of past experiences into heart-mind-hand habits (Adams & Jones, 2022; Benbow & Hora, 2018). Although skills can be classified as 'hard skills' or 'soft skills', previous studies are inconsistent in their classification. For example, some studies identify hard skills obtained by qualifications in the field of Information Technology (IT) to produce system or process functionality, whereas soft skills are those skills relating to communication, building relationships, and presentation skills, while some skills are not classified as hard or soft skills. Consistent classification of hard skills and soft skills is a precondition for developing a visualization application. Categories of skills are important to assist knowledge partners to visualize the skills missing from the IT curriculum. Without classification of skills, the visualization application will be inaccurate (Basson, 2021).

Skills categories are necessary for accurate interpretation of the skills mismatch. For example, Wilson (2012) refers to employers' ongoing message that graduates do not always have suitable soft skills to meet the expectations of industry, yet the skill of logical reasoning is not classified. Industry is looking for skills such as self-management, teamwork, problem solving, communication skills, as well as applications of IT and numeracy (Wilson, 2012). To ensure that graduates are adequately equipped, the importance of classifying and analyzing skills as hard skills and soft skills became quite significant in research done by Patacsil & Tablatin (2017). To illustrate the importance of classification of skills for visualization accuracy, Appendix A presents a synthesis of literature on the skills obtained by students enrolled for qualifications in the field of IT, for example, logical reasoning is not classified as a hard or

soft skill according to the WEF Report (2016), and Watson & McConnel (2018). Appendix A categorizes hard skills (H), soft skills (S), or skills not classified (NC).

It is important to have skills categories such as hard skills (H), soft skills (S), and not classified (NC), otherwise the visualization of any skills mismatch will be flawed.

Visualization

In this article, visualization refers to the visual representation of the skills mismatch. Visualization presents data in a comprehensive manner to interested parties (Gatto, 2015; Ginde, 2016; Verdinelli & Scagnoli, 2013). A graphic representation of the skills supply and demand could assist the WIL process assist educators in focusing more on teaching what industry needs, as opposed to focusing on teaching techniques and curriculum materials. The benefit of visualization is to assist the WIL community in understanding the data represented through visualization in order to make informed decisions. Graphical representation helps data to be structured in such a way that the brain can make comparisons and identify patterns much faster (Ginde, 2016). Visualization is an outcome of the skills data IT application that has been developed in this research objective.

OBJECTIVE

The objective was to develop a visualization tool for WIL stakeholders. Although numerous WIL initiatives are successfully in place, the visualization of the skills acquired from learning versus skills required by industry is lacking. For the purpose of this article, the following research sub-questions are addressed:

- How can a skills hub contribute towards collaboration in creating visibility of the skills supplied by HEIs and the skills required by industry?
- Who should be the contributing knowledge partners in the process of knowledge exchange?
- Which skills are required for an IT qualification to ensure that a graduate is qualified to enter an IT career in the financial industry?

METHOD

This section describes how the qualitative research approach linked to the process of participatory action research (PAR) enabled visualization through the development of an MVP. Ethical approval was obtained to undertake the work: ethics clearance number IKM2018_021 at the University of Johannesburg. To support the WIL process, it seemed a logical conclusion that HEIs and industry be selected for the research of creating the visualization of the skills data shared between WIL participants. A central collaboration platform was created where HEIs and industry partners could share skills data with the aim to present the skills data shared through visual images. Within the South African context, there are three types of public HEIs namely Comprehensive Universities, Traditional Universities, and Universities of Technology. Participants from all three university types were invited to contribute. A Multinational Financial Institution, Consulting partners, and a Skills Assessment partner were selected to represent industry. The inclusion criteria were purposefully chosen as follows:

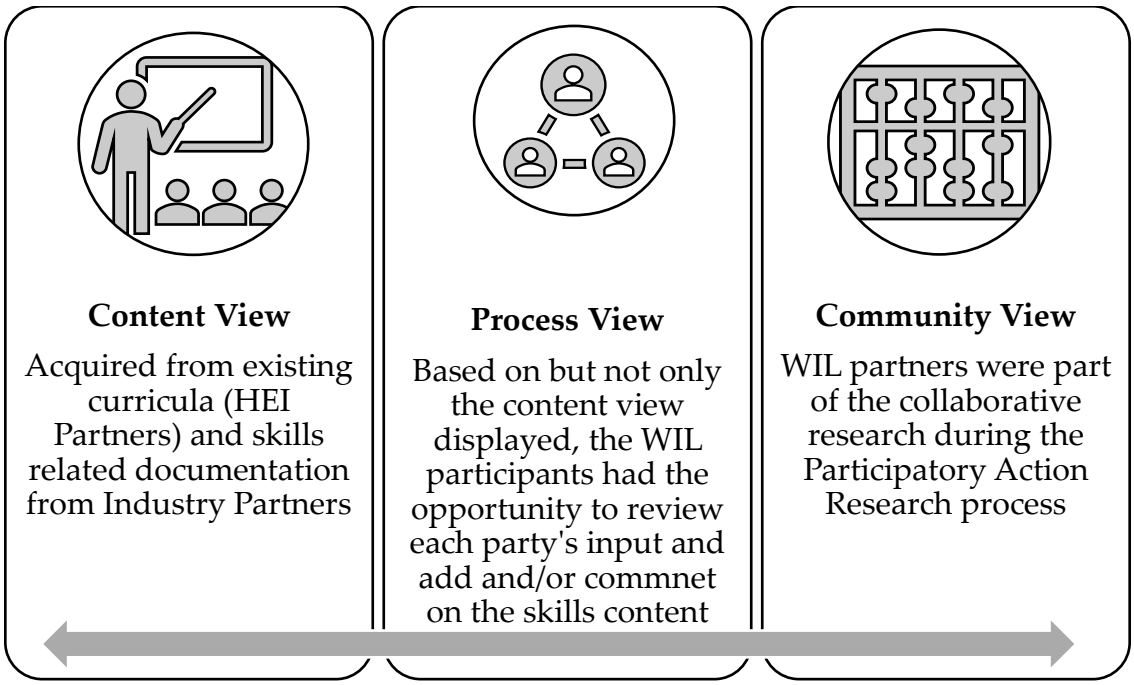
- The setting for collaboration to enable the visualization of the supply and demand of skills was determined to be the skills hub.

- The contributing participants were selected based on the environment that they represented; WIL stakeholders could gain a better understanding of skills requirements and challenges if participants shared knowledge within their work setting.
- The skills hub knowledge sharing event was chosen as the event to observe the interaction of the participants with the skills data provided.

For WIL to be rolled out successfully, the active participation of each WIL stakeholder was required to understand skills content and skills context within each other's work environment in the trialogical process as follows and illustrated in Figure 1:

- Knowledge acquisition relates to the content view. Existing IT curricula and skills documentation as provided by the contributing knowledge partners allowed for the acquisition of skills data.
- Participation relates to the process view. The contributing knowledge partners had the opportunity to review the skills data presented through the various PAR iterations.
- Knowledge creation relates to the community view. The collaboration process which occurred in PAR assisted in reviewing the current skills and participants could add or make changes to the skills data presented to them.

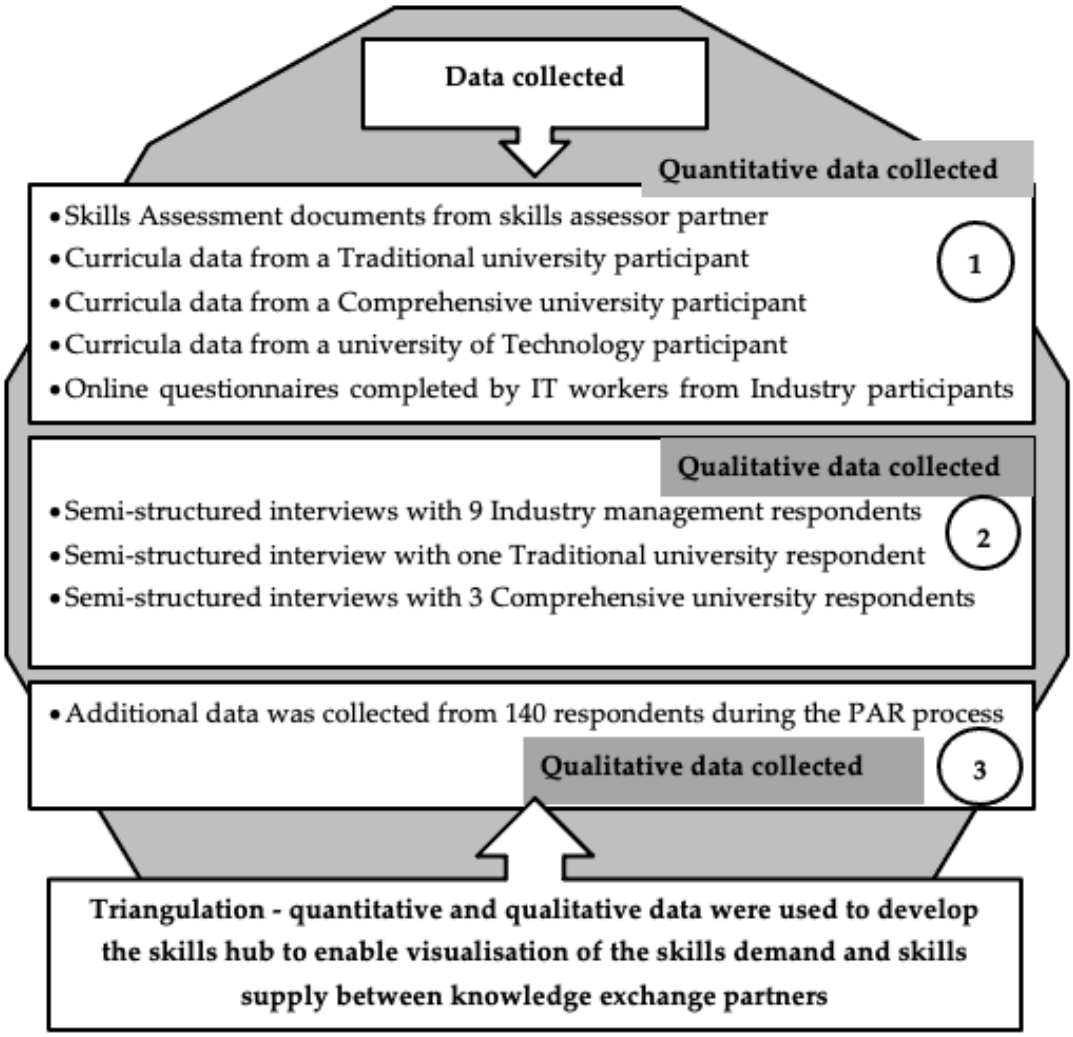
FIGURE 1: Trialogical process applied to this research.



Next, in Figure 2, the methodological framework illustrates the multimethod process for data collection to enable the visualization of the data shared by knowledge partners. A total number of 265 participants agreed to contribute towards the PAR process in a negotiated research governance process of knowledge sharing. This approach aligns with the view of Thorgeirsdottir (2015) which refers to activity theory being about participant collaboration throughout the research process. The data collection process involved gaining insights about skills through continuous collaboration between the

participants involved, as well as skills data collected through relevant documents as illustrated in Figure 2.

FIGURE 2: Multimethod data collection methodological framework.



In Figure 2, the skills assessment documents refer to skills data that were collated during the recruitment process to determine the skills of an individual for employability purposes. Curricula data comprised of skills linked to modules within the field of IT. The interviews consisted of questions to gain insights or concerns from participants regarding the value of a central platform to enable collaboration between WIL partners and the graphical visualization of the skills mismatch. Additional data which was collected via the PAR process refers to the addition of skills data not previously collected during the interviews or documentation. Participants were allowed to add additional data directly on the online platform. The advantage of collecting skills data via a PAR process was that the data provided had been validated and approved by the suppliers and consumers of the data itself.

In presenting the skills mismatch in a visualized manner, two key components were required. The first component was a central place for knowledge partners to share their vested interest in skills, whether it is in the supply of skills or the demand of such skills. The second component was collaboration to

build the skills knowledge base for enabling visualization. Collaboration was achieved through the PAR process between the knowledge sharing participants. During the PAR iterative process, the skills data that was shared was used to build the skills database with the intention to develop a MVP for visualizing the collective data obtained. In research projects where collaboration is required, visualization is often used during the process (Verdinelli & Scagnoli, 2013; Yin, 2011), as an interpretivist approach to strengthen the collection and analysis of qualitative data. The collaborative process between the contributing knowledge partners was required to be initiated within the skills hub. The skills hub was developed as the knowledge partners would enter skills data through a secured link. Access was provided to each contributing knowledge partner to capture and share skills data from their workplace. In addition, the skills hub enabled collaboration virtually as the participating HEIs and industry participants could comment on skills shared by the respective knowledge partners.

To facilitate the collaboration process within PAR, four action research steps were applied during the research as proposed by Kemmis and McTaggert (2005). The steps involved plan, act, observe, and reflect. The process enabled the collection of sufficient research data which could be presented by means of visualization. The four action steps were applied through two PAR cycles, explained below.

Cycle 1

Plan – included the researcher's purposeful selection of participants within the IT field from HEIs and industry. The rationale was to ensure that appropriate participants would provide skills data within a real-world environment during the time of the research. The PAR process was explained to the selected participants during the Plan phase.

Act – to create the skills base, contributing industry partners shared the skills in demand by industry by completing an online questionnaire. The contributing HEIs received a link to the skills hub to indicate which skills were applicable to IT curricula. Further, the researcher collected documentation from the contributing HEIs, and captured skills identified from the IT curricula on the skills hub. Lecturers from the participating HEIs were given the opportunity to validate the skills uploaded by the researcher. The intent of cycle one was to enable the initial collaborative process by creating the skills base for developing the MVP.

Observe – the contributing industry partners received a secure link to review the skills supplied by the HEIs. This allowed the participants to either match the industry skills in demand to the skills supplied by the contributing HEIs or add skills which were not mentioned by the HEIs but are required within the field of IT in the workplace.

Reflect – in cycle one, reflection was not required as no findings were produced that would facilitate the visualization of the skills supplied versus the skills in demand.

Cycle 2

Plan – the researcher shared the results of cycle one to all participating knowledge partners through secure links to the MVP.

Act – participants had the opportunity to add, change and validate the skills content as part of the final review.

Observe – the results of the final skills data were presented to the contributing partners, which results were then added to the research results.

Reflect – the results of the data collected via the PAR process were included in Basson (2021), chapter 4, discussed next.

RESEARCH RESULTS

Applying visualization to research results is used often (Verdinelli & Scagnoli, 2013), however, in this research the term visualization needed to be clearly understood. Visualization in this research is concerned with the MVP (skills hub) as it represents the presentation of the IT skills in demand shared by the participating industry partners and the skills supplied by participating HEIs. A total of 366 skills were shared by the participating partners through the participatory action process via the MVP. Visualization based on the application was done by means of Venn diagrams to represent data in an aggregated manner and through hierarchical edge bundling where it was required to show a holistic skills view per participating HEI as well as a combined HEI view. The detailed skills were mapped through a qualitative data analysis software package (Atlasti.8) to facilitate a summarized view of the skills.

Venn diagrams were best suited to show the overlap, or lack thereof, between skills demand and skills supply. Venn diagrams reflect relationships and overlaps between data in a summarized manner (Gunstone & White, 1986; Verdinelli & Scagnoli, 2013). The summarized results indicated that participating HEIs could meet some of the IT skills required by the participating industry partners. The Venn diagram in Figure 3 represents the relationship between the supply of skills by participating HEIs and the demand from the participating financial institution in a summarized manner. The dotted circle is a representation of the industry participants, and the number represents the skills matched by the participating HEIs. A hierarchical edge bundling was used for visualizing the proportion between the hard skills and soft skills supplied by the current IT curricula, in comparison to the demand from industry. This form of visualization is applicable for the visual presentation of a large number of adjacent relationships as it decreases visual cluttering (Holten, 2006).

FIGURE 3: A Venn diagram reflecting the skills mismatch between the participating HEIs and industry within the field of IT in an aggregated skills category.

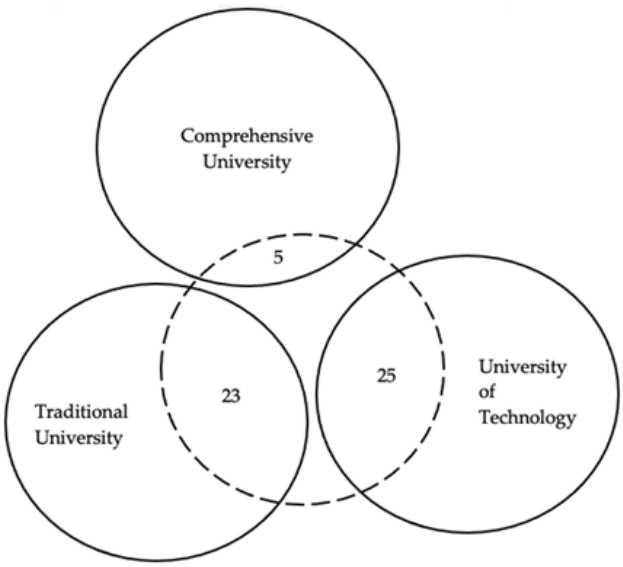
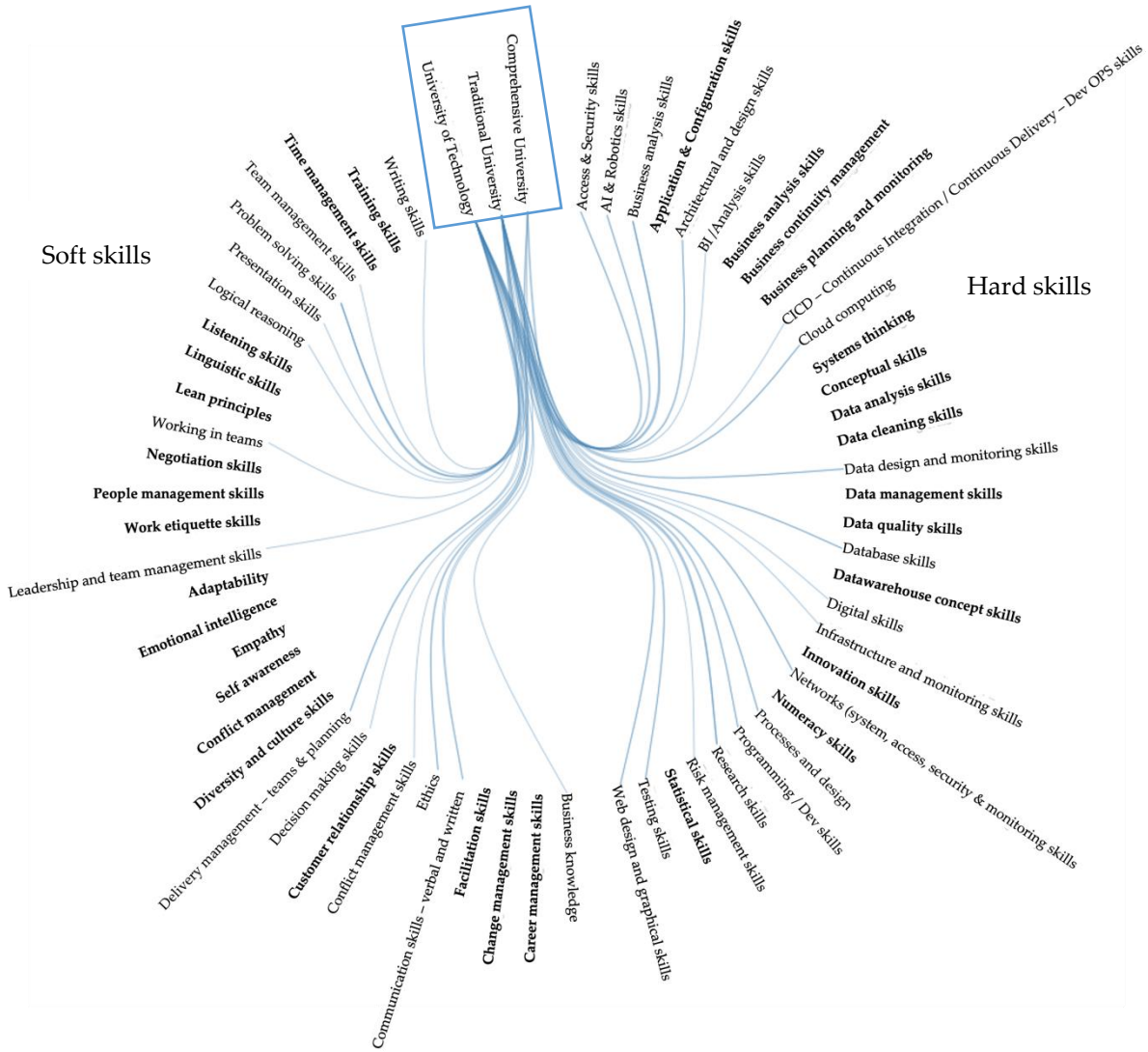


Figure 3 illustrates through visualization two core 'gaps' between HEIs and industry can be addressed, specifically in this instance the skills mismatch and collaborative involvement between HEIs and industry. It is worth highlighting that the participating Comprehensive University was not as collaborative as the other participants.

To understand the magnitude of how the mismatch is caused relating to hard skills and soft skills, a hierarchal edge bundling as per Figure 4 was used to visually present the holistic results across the participating HEIs and the skills categories. The hierarchical edge bundling views have been enabled directly from the skills input by the participating partners within the skills hub. The links depict the mismatch between the HEIs and the total skills in demand by the participating industry partners.

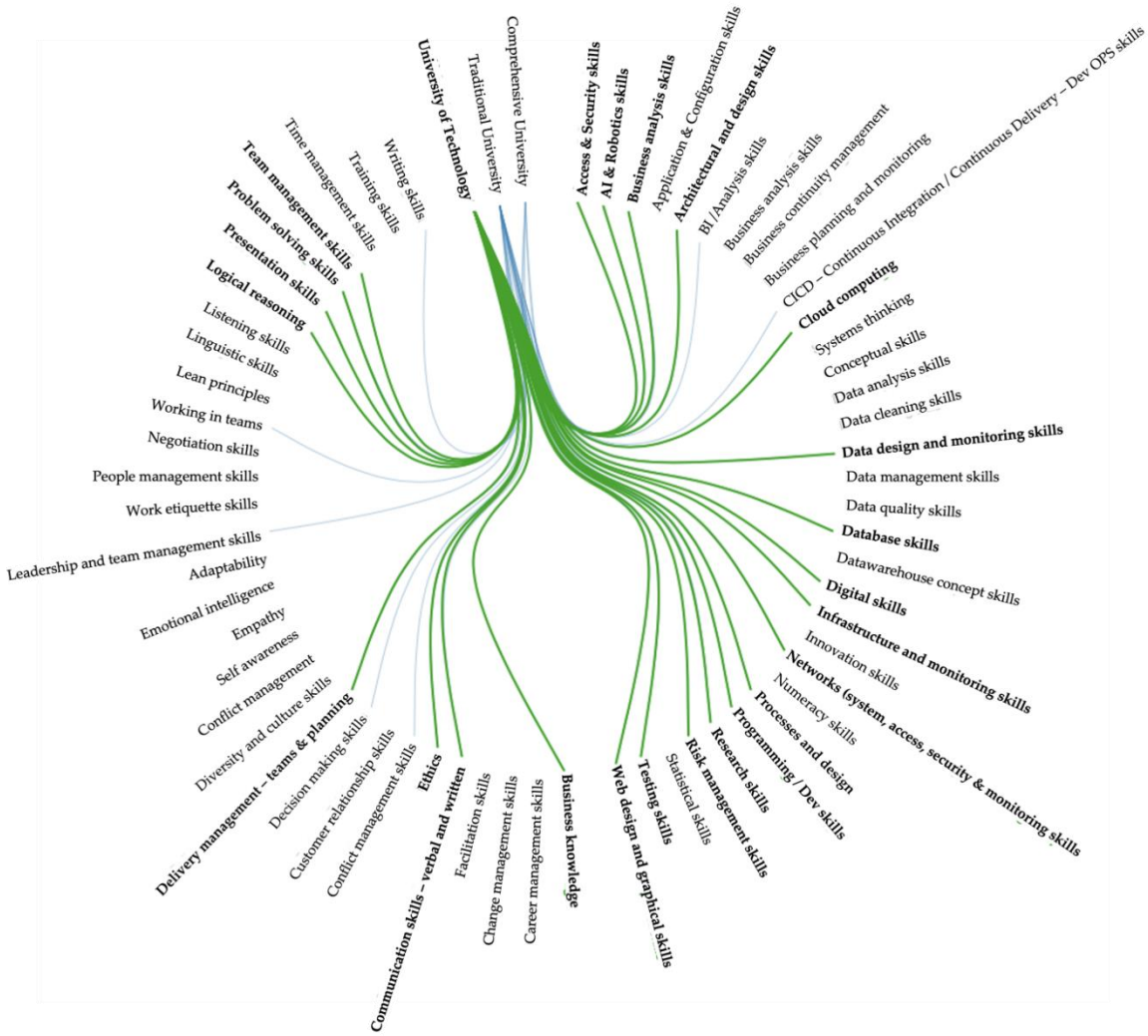
FIGURE 4: The hierarchical edge bundling diagram showing the hard and soft skills mismatch between the participating HEIs and industry within the field of IT.



In Figure 4, the summarized results indicate that the participating HEIs supply of skills could match 18 of the 31 hard skills that are in demand and in the same manner, 13 of the 30 soft skills. Through visualization, minimal narrative is required to depict where the skills supply is aligned or lacking for those skills required within the field of IT. In addition, visualization of the skills mismatch can help educators to understand the cause of a skills mismatch that exists. For example, Peha (2011) raised a concern that educators are focused on teaching techniques and curriculum materials, whilst the focus should be on the 'what' and not the 'how.' The 'how' focuses on understanding industry's needs.

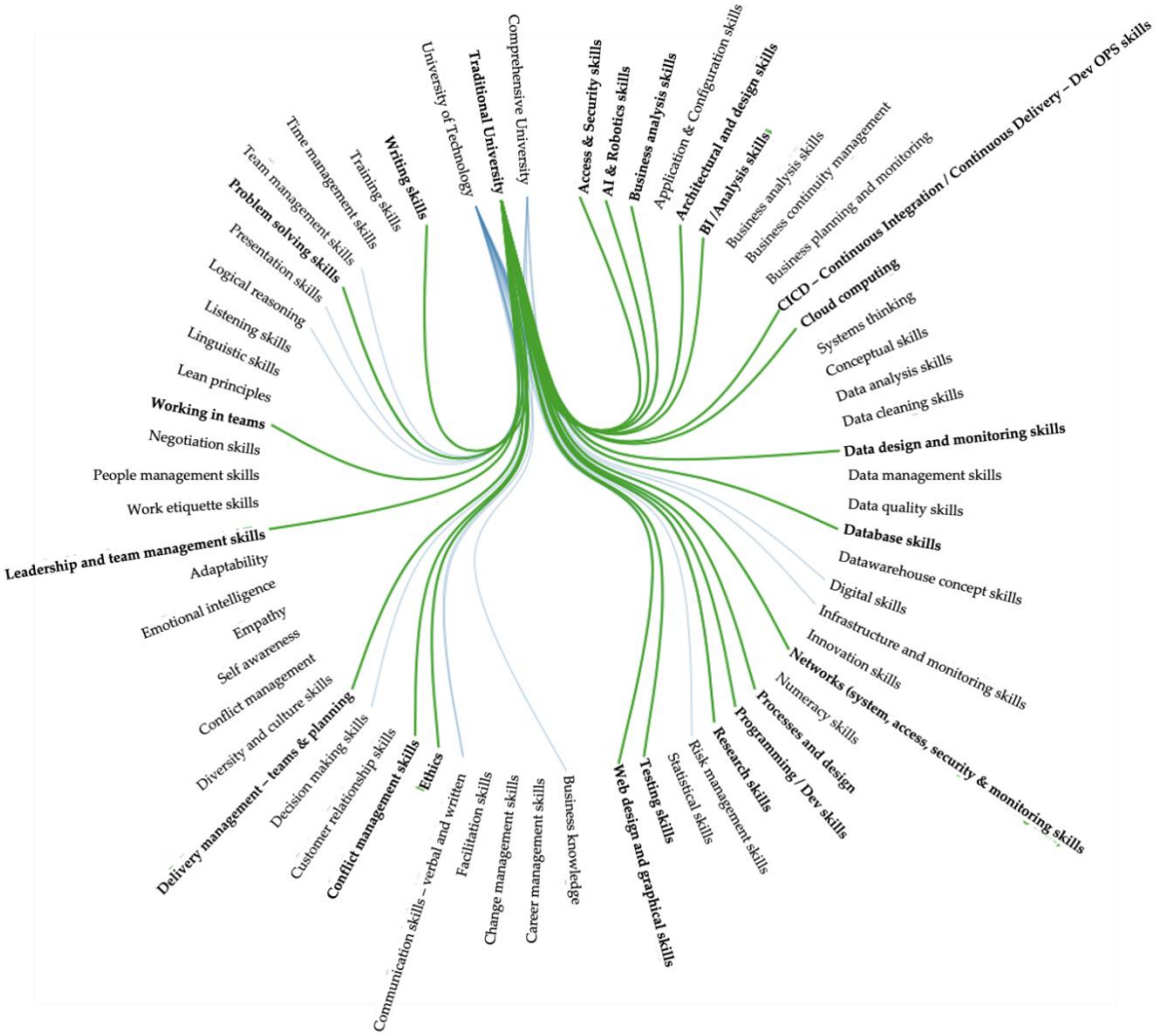
Figures 5 to 7 show a more detailed view for each participating HEI enabling educators to get a sense as to whether curricula material should be adjusted in a more rigorous manner to meet the ever-changing skills demand of industry. In this manner the MVP visualization application provides each participating HEI the opportunity to review their skills supply within the IT curricula. An explanation of Figures 5 to 7 follow after each figure.

FIGURE 5: Hierarchical edge bundling diagram showing the hard and soft skills match between the participating University of Technology and industry within the field of IT.



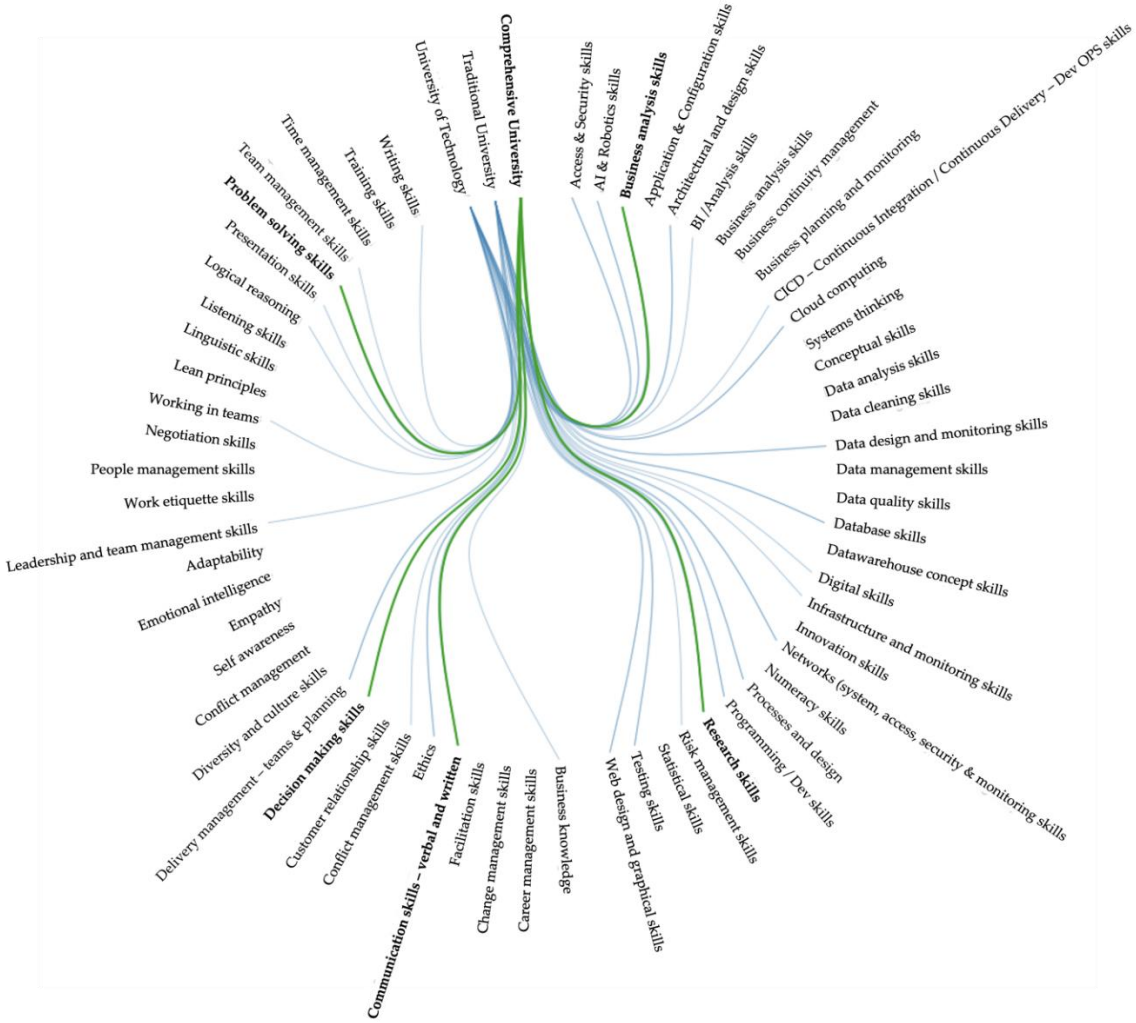
In Figure 5, the visualization application illustrates that the University of Technology matched 26% of the overall soft skills requested by the participating industry partners within the field of IT and 56% of the hard skills in demand.

FIGURE 6: Hierarchical edge bundling diagram showing the hard and soft skills match between the participating Traditional University and industry within the field of IT.



In Figure 6, the Traditional University matched 23% of the soft skills in demand and 48% of hard skills in demand within the field of IT.

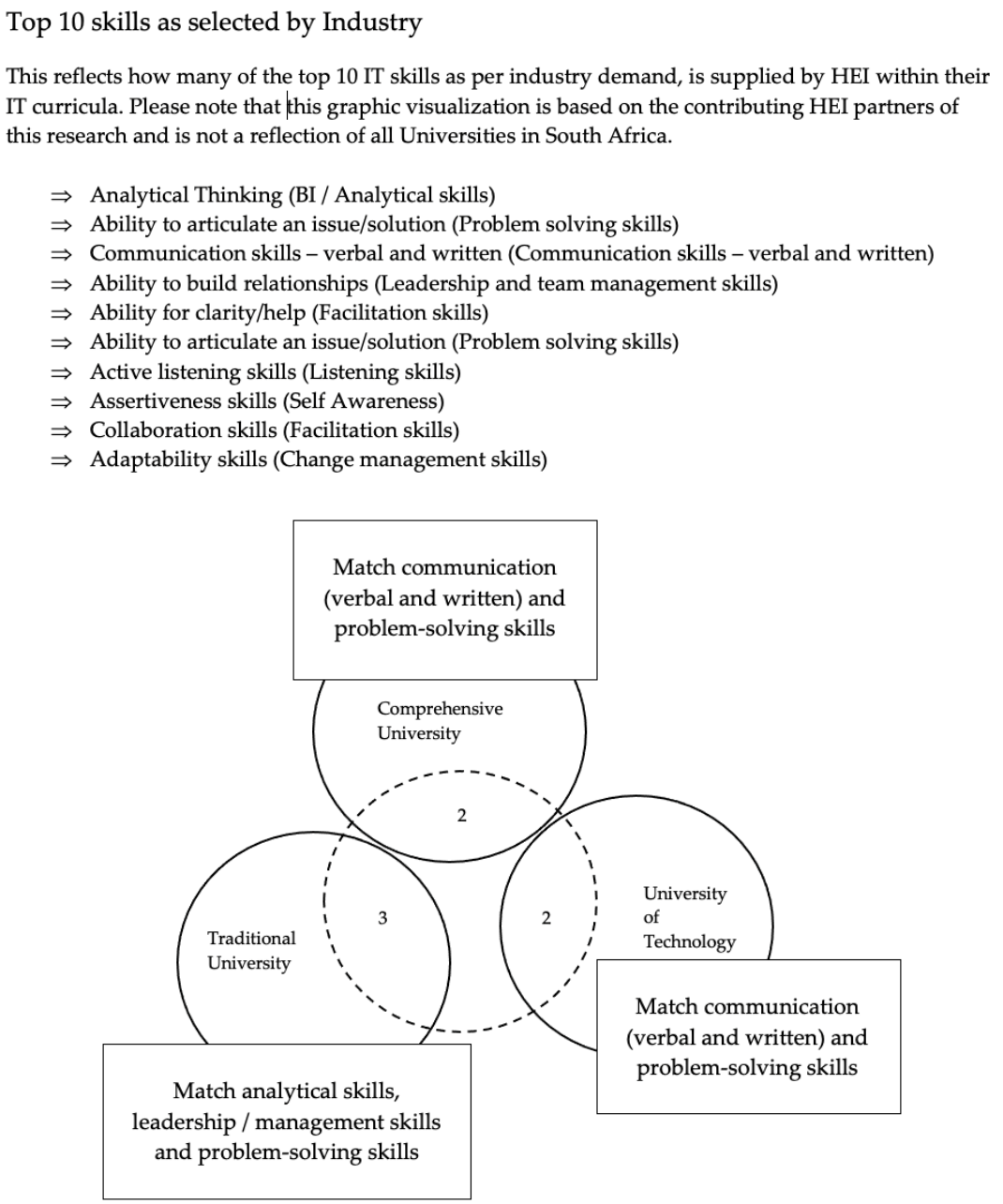
FIGURE 7: Hierarchical edge bundling diagram showing the hard and soft skills match between the participating Comprehensive University and industry within the field of IT.



In Figure 7, the visualization application illustrates the participating Comprehensive University only matched 10% of the soft skills in demand and 6% of the hard skills.

As this research was based on PAR process, the results cannot be compared between the participating HEIs, but rather to place emphasis on the visualization of the skills mismatch between HEIs and industry. It is eminent from the visualized results that IT curricula consist of mainly hard skills. However, based on the current demand by industry, the need is more towards soft skills. The individual HEI findings indicated that the skills supplied by HEIs are not sufficiently comprehensive, it does not clearly show the skills overlap or skills mismatch. In Figure 8, the Venn diagram shows an overlap or the lack thereof of the top ten skills selected by the participating industry partners.

FIGURE 8: Venn diagram reflecting the top 10 skills matches between the participating HEIs and industry within the field of IT.



A Venn diagram is used when a summarized view is required to represent a specific outcome (Gunstone & White, 1986; Verdinelli & Scagnoli, 2013). Figure 8 presents a list of the top ten skills and how the participating HEIs matched the top skills. The participating HEIs could only match 20% and 30% of the top skills selected by the participating industry partners. Only problem-solving as a skill could be matched by all the participating HEIs. It appears that soft skills are not often provided within IT curricula. It was worth equating the research results provided by the participants within the MVP

to the skills provided by a study conducted by Bughin et al. (2018) for the McKinsey Global Institute. In relation to comparing the skills shared during this research to the 2018 McKinsey Global Institute findings, six out of the top ten skills selected by the industry participants could be linked to the top ten skills identified by McKinsey Global Institute for 2020. As an abductive approach was applied to this research, the results from the top ten skills ranked by the participating industry partners provide an indication of new skills required by industry in comparison with the expected skills selected by the McKinsey Global Institute in 2018 as per Table 2.

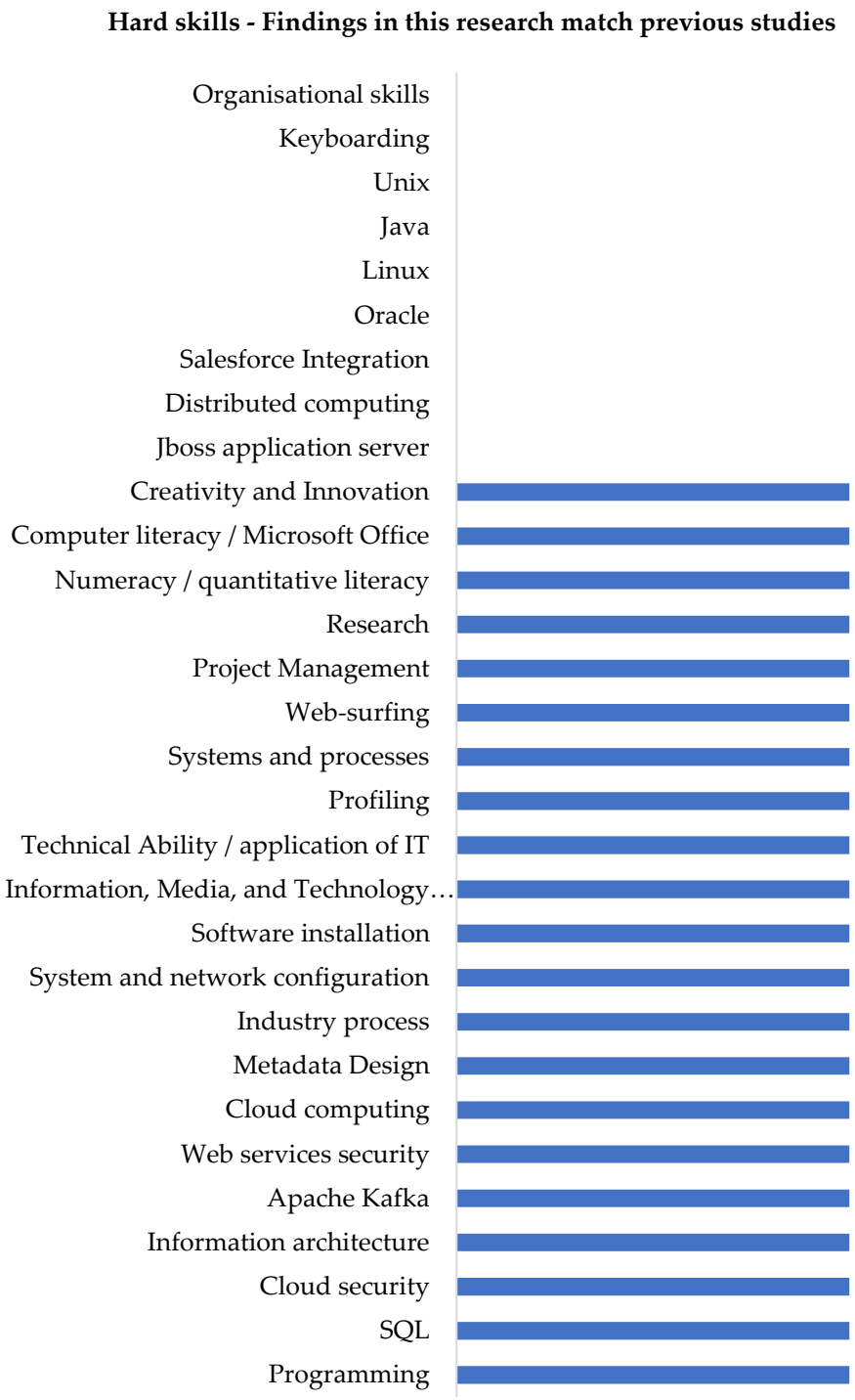
TABLE 2: Top 10 skills selected by industry participants ranked to the top ten skills according to McKinsey for 2020).

Top ten skills required by 2020 as per McKinsey - not ranked	**McKinsey top ten skills matched as per the industry participants' ranking**	**Participating industry partners' top ten ranking**	**Top ten skills selected by the industry partners in this research (ranked)**
Cognitive Flexibility	**10**	**1**	Analytical thinking
Complex Problem Solving	**2**	**2**	Ability to articulate an issue / solution
Coordinating with others	**9,4**	**3**	Communication skills
Creativity		**4**	Ability to build relationships
Critical Thinking	**6**	**5**	Asking for clarity / help
Emotional Intelligence	**8**	**6**	Critical thinking
Judgement and Decision Making		**7**	Active listening
Negotiation		**8**	Assertiveness
People Management		**9**	Collaboration skills
Service Orientation		**10**	Adaptability skills

In addition, due to the abductive nature of this research, it made sense to compare the findings of hard skills and soft skills against the skills identified in aforementioned literature (Appendix A). The main purpose of abductive reasoning would be the combination of inductive and deductive reasoning in this research. Abduction provides the opportunity to gain new insights (Nenonen et al., 2017). Furthermore, abduction refers to the viewing of existing theory to either modify or adding new knowledge (Saunders et al., 2019). Consequently, the most suitable approach for this research was inductive abduction, as the aim of this research was to provide a visualization of the skills mismatch.

The visualization of the skills mismatch highlights where contributing knowledge partners can add knowledge to the existing IT skills data which has been identified in previous studies. For example, Figure 9 is a visualized representation of the hard skills shared during this PAR versus what has been highlighted in previous studies. The highlighted skills are those skills which have previously been identified (Appendix A).

FIGURE 9: A visual display of the hard skills shared in this research in comparison to hard skills mentioned in previous studies.



Through visualization, an awareness can be created by highlighting where specific skills are still relevant or where new skills have been identified and as a result, it reflects the current needs of industry. A similar view is displayed for soft skills in Figure 10.

FIGURE 10: A visual display of the soft skills shared in this research in comparison to soft skills mentioned in previous studies.

It is evident that additional soft skills have also been mentioned by industry participants within the IT field. Output through visualization needs to have sense and meaning, therefore, the visualization of data should be a representation of words in action (Engeström, 2001). Examples of how graphical representations can provide sense and meaning is depicted in Figures 11-13. The dotted circle represents the skill requested by industry.

FIGURE 11: A visual display reflecting a hard skill match as per the demand by the contributing financial institution. Two of the three participating HEIs met this demand.

University of Technology

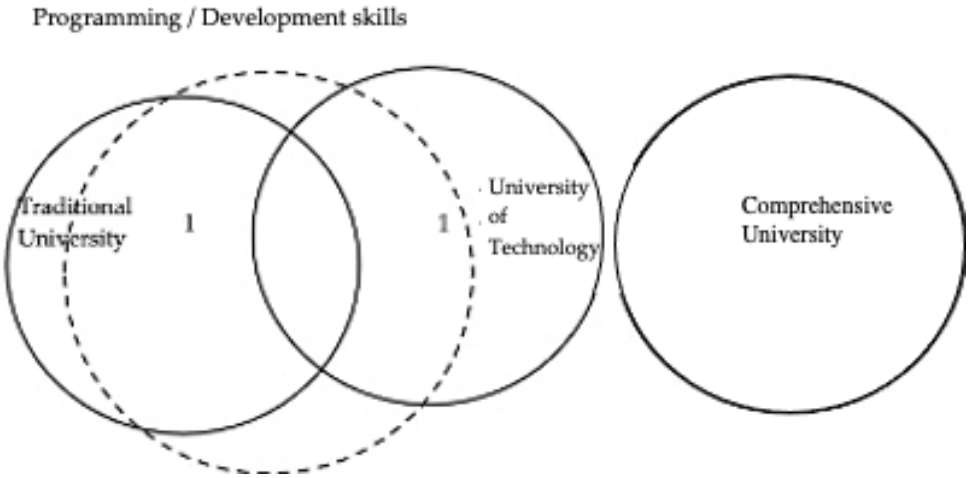
⇒ Advanced Structured Query Language
⇒ Basics to .Net Platform, C# Programming Language
⇒ Creating Asynchronous Java Script Functions, Working with Java Script Frameworks, Fields, Properties & Indexers Constructors and Finalizes Operators, Overloading and
⇒ Conversions Object Oriented Programming Generic Types and Methods Collection Types Delegates Events Language Integrated Query Essentials Exceptions Working with IO Introduction .Net Platform Introducing the C# Programming Language Getting start with .NET developing using C# Language Essentials Expressions and Operators Primer
⇒ Types and Objects Simple Flow Control Basics of Exception and Resource Management Introduction Types Methods
⇒ Introduction to Structured Query Language

Comprehensive University

No skills were identified under this grouping as per the information shared in this research

Traditional University

⇒ How to apply the NET programming language environment to the solution of commercial problems
⇒ Learn to program in C# learn how to apply your skills in a commercial IS environment
⇒ Programming
Programming Action
⇒ Structured Query Language (SQL) and ActiveX Data Objects (ADO) in C# - Microsoft technologies



In Figure 11, not only does the Venn diagram clearly reflect the mismatch by the Comprehensive University, but the skills grouped under the category programming and development skills are visible.

In the next figures, the user of the skills hub visualization tool will notice a visual display of a skills mismatch (Figure 12), compared to the skills match (Figure 13).

FIGURE 12: A visual display reflecting a hard skill not being matched by any of the participating HEIs.

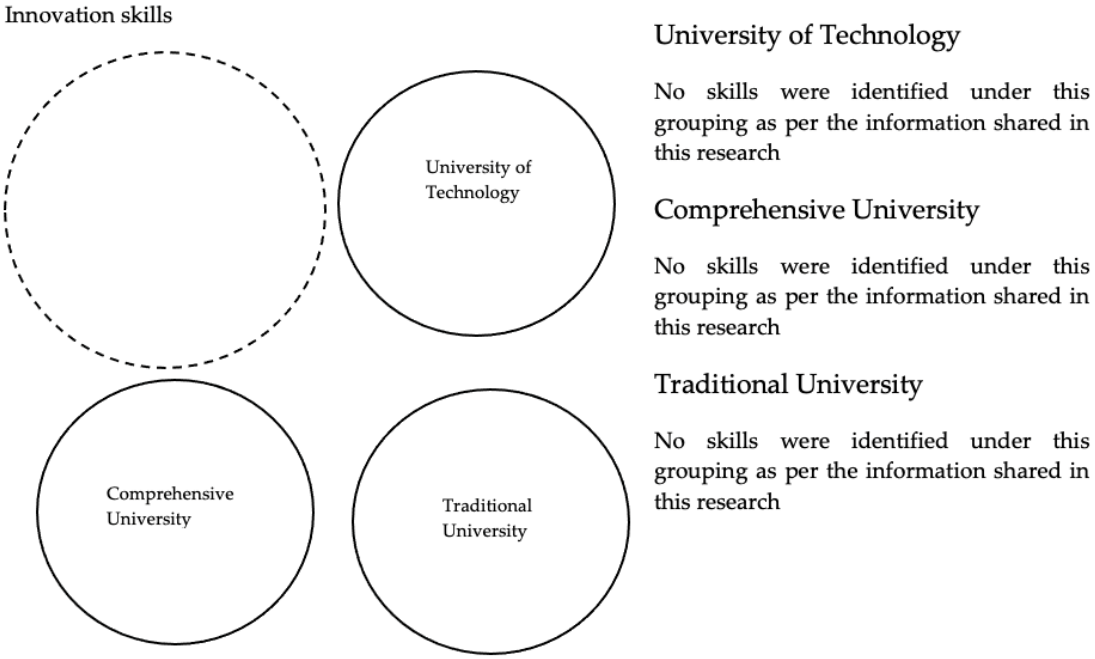
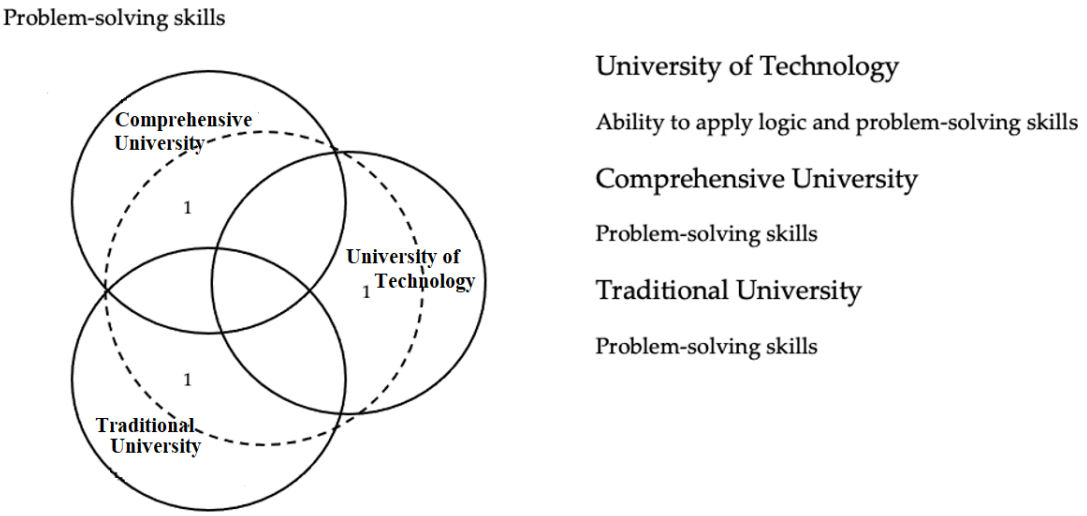


FIGURE 13: A visual display reflecting a soft skill where all three participating HEIs matched the demand by the participating industry partners.



In summary, as part of the WIL process educational stakeholders need to consider enriching soft skills and entry level hard skills components in IT curricula. This coincides with a study conducted by Patacsil and Tablatin (2017) in the IT field in the Philippines. Findings from their research indicated that teamwork and communication skills are significant soft skills for IT graduates. However, their findings contradict the results in the case of hard skills. IT students believed that hard skills were important while industry perceived hard skills as somewhat important.

Participant Feedback

Further to the data collection and results shared from the PAR, semi-structured interviews were conducted to understand the challenges knowledge partners experience in addressing the skills mismatch. From the responses received as to whether a skills hub could enhance or create collaboration between knowledge partners, it was confirmed that a virtual interface can support the exchange of knowledge. The importance of the feedback received as a result of this research sub-question is that a virtual interface can assist in creating visibility, that is, visualization on the skills mismatch. The lack of visualization was the second highest concern to the participants of this research.

The research participants were asked to share their opinion regarding what the value of a visualized view should provide. Four main points were noted:

1. Visualization should highlight industry skills requirements.
2. The latest skills to be work-fit should be easily identifiable.
3. Skills trends and patterns should be established through the process of visualization.
4. The visualization application should allow for the skills mismatch to be addressed.

Visualization on its own will not address the skills mismatch, however it will enable knowledge partners to identify the gap. Once the gap has been closed and the skill has been shared via the skills hub, the visual display will immediately display the alignment. The latter could also address the lack of agility that was mentioned as a major source of frustration by respondents of the Comprehensive University and Traditional University. According to the respondents, the business market pace is too fast for HEIs to adapt curricula within a short timeframe. The intention of creating visualization is to assist knowledge partners with an immediate view of skills that require immediate attention.

Data collected via a supporting question relating to the research sub-question: 'How can a skills hub contribute towards collaboration to help create visibility of the skills supplied by HEIs and the skills demanded by industry?' the following results were shared:

1. Six out of fourteen interviewees believed a skills hub would be of value for collaboration and that it would create a link between HEIs and industry. Four of the six responses were from industry participants.
2. With regard to visibility, only participants from industry felt that visibility through a skills hub would enhance collaboration. To the contrary, the Comprehensive University respondents were of the opinion that the lack of visibility was not the problem, but rather that collaboration was not enforced between HEIs and industry.
3. An interesting trend that surfaced is that industry respondents were of the opinion that HEIs might feel that they would lose the competitive advantage when sharing skills information via the skills hub and they would therefore not participate in a collaboration process. Contrary to industry's responses, HEI respondents were of the opinion that HEI and industry might compete with each other.

These findings illustrate the differences of opinion of WIL stakeholders and highlight the importance of using a visualization tool. This study has developed a MVP to be utilized as a visualization tool which may be used by WIL stakeholders to visualize the mismatch of the skills supply and skills demand. These findings emphasize the importance of collaboration between WIL stakeholders. WIL stakeholders may benefit from the skills hub as an application that has provided a process to translate the skills shared by the research participants in a visualized manner. Resulting from this visualization, the skills alignment between knowledge partners can be tracked in a near real-time manner. Knowledge partners can use the visualized output to implement remedies for addressing the skills mismatch. The purpose of updating the shared skills is to enable a view to highlight whether the skills gap is diminishing or not.

Limitation

Subjectivity could relate to how the contributing knowledge partners interpret the visualization of the skills demand and supply as it is based on their view of the world. The business value and strategic importance for knowledge partners who want to contribute towards an initiative that will create visualization of the skills supply and demand, needs to be the compelling reason to act.

CONCLUSION

WIL stakeholders will benefit from a virtual system to manage the exchange of information between graduates and industry (Brink, 2013). In this study, during the development of the MVP as a virtual system, the skills mismatch was made visible through graphical views. The results of the visualization of the skills mismatch, as produced through the contribution of various knowledge partners, will assist in selecting the most appropriate skills content to meet industry demand. Visualization will help HEIs become aware of the curricula that require adjusting to reduce the delay of the skills supply. Visualization could entice knowledge partners to address the skills mismatch through collaboration. Visualization will create an awareness of the skills in demand and assist HEI knowledge partners to consider adjusting the academic curricula and to reduce any delay in supplying those skills that are most in demand as part of the WIL process.

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APPENDIX A: Synthesis of literature on skills obtained by qualifications in the field of IT (Basson, 2021).

Skills	Category	Literature										
Qualifications in Information Technology		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Programming	NC					x						
Logical Reasoning	NC	x				x						
SQL	H							x				
Cloud security	H							x				
Technical Ability / Application of IT	H									x		x
Self-management / Initiative / Self-direction	S	x	x						x	x		x
Jboss application server	H							x				
Problem solving (incl. Complex problem solving)	S		x			x		x		x		
Distributed computing	H							x				
Information architecture	H							x				
Apache Kafka	H							x				
Systems and processes	H		x									
Web services security	H							x				
Profiling	H		x									
Salesforce Integration	H							x				
Cloud computing	H							x				
Metadata Design	H							x				
Oracle	H							x				
Oral presentation skills	S											x
Industry process	H							x				
Linux	H							x				
System and network configuration	H							x				
Software installation	H							x				
Java	H							x				
Unix	H							x				
Information, media, and technology skills	H						x					
Keyboarding	H		x									
Web-surfing	H		x									
Word processing	H			x								
Information literacy	H			x								
Ethics / Citizenship	S		x									
Ability to find / access information	S											x
Ability to use new information	S											x
Large information handling skills	NC											x
Sense of identity and confidence	S											x
Willingness to learn	S											x
Teamwork / collaboration[12]	S		x	x					x	x	x	x
Troubleshooting	S							x				
Project Management	NC							x				

Skills	Category	Literature										
Qualifications in Information Technology		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Exposure to work	NC											x
Business Acumen	NC											x
Organizational skills	S							x				
Networking skills	NC											x
Research	S							x				
Customer service	S							x				
Planning skills	S							x				
Proficiency in English	S											x
Writing skills	S				x			x				x
Numeracy / quantitative literacy	S									x		x
Computer literacy / Microsoft Office	S							x				x
Communication skills[13]	S	x	x	x				x	x	x		
Critical thinking	S	x	x			x						
Creativity and innovation	S		x			x	x					x
Openness and flexibility	S		x									x
Adaptability	S		x									
Cross-cultural interactions[14]	S		x									x
Productivity	S		x									
Accountability	S		x									
Leadership ability	S		x									x
Negotiation and mediation	S											x
Listening skills	S								x			
Empathy / compassion	S								x			
Integrity	S								x			
Honesty	S								x			
Life and Vocational skills	S						x					

Note. 1. Watson & McConnell (2018); 2. Chu et al., (2017); 3. Patacsil & Tablatin (2017); 4. Knoch et al., (2016); 5. WEF Report (2016); 6. Farisi (2016); 7. Burning Glass Technologies (2015); 8. Kamin (2013); 9. Wilson (2012) 10. Daud et al., (2012); 11. Griesel & Parker (2009); 12. Including group dynamics and team building; 13. Includes written and verbal communication skills; 14. Ability to relate to wide range of people.

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About the Journal

The International Journal of Work-Integrated Learning (IJWIL) publishes double-blind peer-reviewed original research and topical issues dealing with Work-Integrated Learning (WIL). IJWIL first published in 2000 under the name of Asia-Pacific Journal of Cooperative Education (APJCE).

In this Journal, WIL is defined as "*an educational approach that uses relevant work-based experiences to allow students to integrate theory with the meaningful practice of work as an intentional component of the curriculum. Defining elements of this educational approach requires that students engage in authentic and meaningful work-related task, and must involve three stakeholders; the student, the university, and the workplace"*. Examples of practice include off-campus, workplace immersion activities such as work placements, internships, practicum, service learning, and cooperative education (Co-op), and on-campus activities such as work-related projects/competitions, entrepreneurships, student-led enterprise, etc. WIL is related to, and overlaps with, the fields of experiential learning, work-based learning, and vocational education and training.

The Journal's main aim is to enable specialists working in WIL to disseminate research findings and share knowledge to the benefit of institutions, students, co-op/WIL practitioners, and researchers. The Journal desires to encourage quality research and explorative critical discussion that leads to the advancement of effective practices, development of further understanding of WIL, and promote further research.

The Journal is ongoing financially supported by the Work-Integrated Learning New Zealand (WILNZ; www.wilnz.nz), and the University of Waikato, New Zealand, and received periodic sponsorship from the Australian Collaborative Education Network (ACEN) and the World Association of Cooperative Education (WACE).

Types of Manuscripts Sought by the Journal

Types of manuscripts sought by IJWIL is primarily of two forms: 1) *research publications* describing research into aspects of work-integrated learning and, 2) *topical discussion* articles that review relevant literature and provide critical explorative discussion around a topical issue. The journal will, on occasions, consider good practice submissions.

Research publications should contain; an introduction that describes relevant literature and sets the context of the inquiry. A detailed description and justification for the methodology employed. A description of the research findings - tabulated as appropriate, a discussion of the importance of the findings including their significance to current established literature, implications for practitioners and researchers, whilst remaining mindful of the limitations of the data, and a conclusion preferably including suggestions for further research.

Topical discussion articles should contain a clear statement of the topic or issue under discussion, reference to relevant literature, critical and scholarly discussion on the importance of the issues, critical insights to how to advance the issue further, and implications for other researchers and practitioners.

Good practice and program description papers. On occasions, the Journal also seeks manuscripts describing a practice of WIL as an example of good practice, however, only if it presents a particularly unique or innovative practice or was situated in an unusual context. There must be a clear contribution of new knowledge to the established literature. Manuscripts describing what is essentially 'typical', 'common' or 'known' practices will be encouraged to rewrite the focus of the manuscript to a significant educational issue or will be encouraged to publish their work via another avenue that seeks such content.

By negotiation with the Editor-in-Chief, the Journal also accepts a small number of *Book Reviews* of relevant and recently published books.

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