Journal of Theoretical and Applied Information Technology
30th April 2024. Vol.102. No 8

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

THE RELATIONSHIP BETWEEN CROSS-CUTTING FACTORS AND KNOWLEDGE, LEARNING OUTCOMES, AND SKILLS IN DUAL DEGREE PROGRAMS

MOHAMMAD HASAN ALTARAWNEH [1], WAEL ALZYADAT [2], BELAL MAHMOUD ALWADI [3], ALA' AL-SHAIKH[4,*], AMEEN SHAHEEN [2], AYSH ALHROOB [2]

[1]Department of Educational Sciences, Classroom Teacher, Faculty of Arts, Al-Zaytoonah University of Jordan
Amman, Jordan

[2] Department of Software Engineering, Faculty of Science and Information Technology, Al-Zaytoonah University of Jordan Amman, Jordan

[3] Department of Basic Sciences (Humanities and Scientific), Faculty of Arts, Al-Zaytoonah University of Jordan Amman, Jordan

[4] Department of Cyber Security, Faculty of Information Technology, Zarqa University
Zarqa, Jordan

E-mail: [1]dr.mohammadt@zuj.edu.jo, [2]wael.alzyadat@zuj.edu.jo, [2]a.shaheen@zuj.edu.jo, [2]aysh@zuj.edu.jo, [3]b.alwadi@zuj.edu.jo, [4]ashaikh@zu.edu.jo

ABSTRACT

This study delves into the pivotal role played by cross-cutting factors within the curriculum life cycle, with a particular emphasis on their impact on the development, implementation, and evaluation of a knowledge-based curriculum. We highlight the National Qualifications Framework (NQF) as a crucial component in ensuring that students acquire subject-specific knowledge and skills. In our research, we underscore the primary goal of the knowledge base integrated into the NQF. A knowledge-based curriculum, as our findings reveal, places a strong emphasis on the acquisition and retention of subject-specific knowledge, skills, and understanding. Regarding learning outcomes, our analysis highlights the focal point of a knowledge-based approach, concentrating on what students should know and understand upon completing a course or program. Our findings illustrate the stress placed on acquiring and retaining specific knowledge and understanding relevant to a particular subject or discipline. Our study suggests that a knowledge-based approach to learning outcomes is invaluable in ensuring that students possess a robust foundation in subject-specific knowledge, which, in turn, contributes to their academic and professional success. This study holds significance for individuals interested in dual study, apprenticeship, and NQF implementation, as it directly addresses the challenge of ensuring that students acquire both the knowledge and skills necessary for their chosen field of study or profession. The role of cross-cutting factors within the curriculum life cycle is a central theme, shedding light on the intricate interplay between knowledge-based education, learning outcomes, and skills development.

Keywords: *E-Learning, Dual study, apprenticeship, National Qualifications Framework, Knowledge.*

1. INTRODUCTION

The structure of higher education effects by several factors such as government policy, market demand, and clutters based on these factors, the structure of higher education request to expand in scope from global perspective, typically the education pathway is full-time educated for students before entry to the labor market, called formal education that considers knowledge, skills, and competencies; the other perspective of higher education structure is vocational education candidate to acquire the knowledge and skills from the relevant labor market to design the learner orientation such as dual study and apprenticeships [1].

Dual study is vocational and academic learning formed two sides of the same coin for the students to ability didactic innovation, and creative. Potentially, established the bridge between universities and vocational through different aspects such as research and development, startup business, and leeway scope

of the potential market. The principle for implementing a dual study shall determine the central levels through an accurate description and a set of instructions to assess the outcome precisely using knowledge, skills, and competencies [2, 3].

Due to the nuances involved in vocational education and training (VET), policies, transfer activities, academic disciplines, whatever government, or nongovernmental sectors are interrelated. The typologies of VET are dialogic definitions such as apprenticeships and dual system education programs. The purpose of VET is to enhance education, learning and build the bridge between vocational and academic, where it is subsumed by policy learning [4, 5].

An apprenticeship is a type of on-the-job training in which a person works for an employer while learning a trade or craft. Apprenticeships can last from a few months to several years, depending on the industry and the specific program [6]. During an apprenticeship, the apprentice works under the guidance of a skilled worker or mentor, who teaches them the skills and knowledge needed to perform the job [7]. Apprenticeships typically combine hands-on training with classroom instruction, and many of them result in a recognized credential or certification upon completion [8]. Apprenticeships are a popular way for people to learn skilled trades and for employers to develop the workforce they need to meet the demands of their industry [9]. A dual study program combines academic study with on-the-job training, while an apprenticeship is a type of on-the-job training program that does not include academic study [10].

In a dual study program, a student is enrolled in a college or university and works for an employer in a related field. The student typically attends classes part-time while also receiving hands-on training and work experience at the employer's place of business. Dual study programs usually last for several years and result in the student earning a degree or other academic credential. An apprenticeship, on the other hand, is a structured training program that focusses mainly on developing practical skills and knowledge through hands-on experience. Apprenticeships do not usually involve academic study, although some programs may include related classroom instruction. Apprenticeships typically last for a shorter period than dual study programs, and upon completion, the apprentice may receive a recognized credential or certification in their field of study [11].

Both dual study programs and apprenticeships can be a good way for students to gain valuable work experience and training in a particular field but differ in their emphasis on academic study and the length and structure of the training program.

Dual study is vocational and academic learning formed two sides of the same coin for the students to ability didactic innovation and creative. Potentially, established the bridge between universities and vocational through different aspects such as research and development, startup business, and leeway scope of the potential market. While the principle to implement a dual study shall determine the central levels through an accurate description and a set of instructions to assess the outcome precisely using knowledge, skills, and competencies [12].

Higher education institutions (universities) design a program that supports knowledge, skills, and competencies, with the support of four factors: the knowledge area represents the amount of material in the field, the knowledge unit considers the subject learning outcomes and learning outcomes that identify subject knowledge and teacher skills application, elements, and factors are regulated in the program curriculum. Although each major program level has a specific curriculum, such as Computing Curricula (CC) released by the Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE) Computer Society over the years. The development of the CC guide, the first version of Computing Curricula, known as CC2001, was released in 2001 and focused on the core body of knowledge in computer science [13]. CC2005, which was released in 2005, expanded on this foundation by adding new topics and providing more flexibility in terms of how the guidelines could be implemented [14].

CC2013, which was released in 2013, continued this trend by further expanding the scope of the guidelines to include new areas of computer science and providing even more flexibility in terms of how the guidelines could be used [15]. CC2014, which was released in 2014, focused on updating the guidelines to reflect the latest developments in the field and on providing more guidance on how to integrate computing into other fields and disciplines [16]. CC2020, which was released in 2020, is the most recent version of Computing Curricula, and it includes updated guidelines and recommendations based on the latest developments in computer science education [17].

Back to a dual study program in same knowledge area for Computing typically consists of the following elements: (1) Academic coursework: Students in a dual study program typically complete coursework in a variety of subjects related to their field of study. This might include lectures, seminars, and other forms of instruction. (2) Practical training: Dual study programs often include practical training and internships with companies in the field, which allow students to apply what they have learnt in a real-world setting and gain valuable industry

experience. (3) Mentorship: Many dual study programs also include mentorship opportunities, where students are paired with experienced professionals who can provide guidance and support as they progress through the program. (4) Co-op work placements: Some dual-study programs also include co-op work placements, which are paid work assignments that allow students to gain additional hands-on experience in their field of study [18].

In general, the goal of a dual-study program is to provide students with a well-rounded education that prepares them for a successful career in their field of study. Some examples of countries where dual study programs are commonly offered include Germany and Switzerland known as duale Ausbildung [19], Austria known as duale Hochschule [20].

The National Qualifications Framework (NQF) is a system that is used in many countries to organize and recognize qualifications from different education and training providers. The NQF provides a framework for describing the knowledge, skills, and competencies that are required for different qualifications, and for linking them to different levels of difficulty and complexity.

A dual study program, which combines academic coursework with practical, hands-on experience in a related field, can be linked to the NQF by providing a structured learning outcome, knowledge units, and program outcomes that are aligned with the NQF levels and requirements [21, 22]. This alignment can be done by mapping the learning outcomes, knowledge units, and program outcomes of the dual study program to the appropriate levels and outcomes in the NQF [23]. This allows students, employers, and other stakeholders to understand the level and breadth of knowledge and skills that the student has and to compare the qualifications of different education and training providers. Additionally, it can give students the opportunity to have more diverse career paths and to be more internationally recognized and comparable to others in the same field.

Although most studies from the dual study program focus on the knowledge area, the learning outcome, these are systematically considered in the section knowledge based.

2. KNOWLEDGE-BASED EDUCATION

In this section, we examine the attributes of knowledge from an academic perspective and the relationship between these attributes.

- *Knowledge Based*

The landscape of the educational process is the knowledge that content and information, including facts, concepts, theories, and principles, are taught, and learned in a particular academic study. According to the proposed theory [24] proposed theory called 'knowledge of the powerful" explored the importance of knowledge in curriculum, and he proposed five main principles to design knowledge-based approach as follows: (1) Its form of specialization by two factors are the boundaries between disciplines and recontextualization (2) The relationship between a national curriculum and the public Individual curricula of schools (3) The difference between conceptual knowledge (curriculum) and content (everyday) knowledge (4) The difference between pedagogy and curriculum, and (6) Assessment as 'feedback' and assessment as the driver of the curriculum.

The knowledge-based approach to curriculum design emphasizes the importance of imparting specific knowledge and skills to students. This approach is based on the idea that there is a body of knowledge and skills that are necessary for students to learn to be successful in a particular subject or field, and that the curriculum should be designed to ensure that students acquire this knowledge and these skills [25].

In a knowledge-based curriculum, the content to be taught is carefully selected and organized, with a clear progression of topics and themes. Emphasis is placed on the acquisition of facts and information, as well as the development of cognitive skills such as analysis, synthesis, and evaluation. In this approach, teachers act as transmitters of knowledge, and students are expected to learn through direct instruction, memorization, and practice [26].

The curriculum is usually highly structured, and assessment is often focused on testing students' ability to recall and apply the knowledge and skills they have learnt [27].

This approach is used by some countries, but there are also various other approaches to curriculum design that place more emphasis on other aspects of student learning, such as critical thinking, problem solving, creativity and more, there are several steps that can be taken to build a knowledge-based curriculum [28, 29, 30].

1. Define the desired learning outcomes: Identify the specific knowledge and skills that students should acquire because of the curriculum. This includes identifying the key concepts, facts, and information that students should learn, as well as the cognitive skills they should develop.

2. Select the content: Choose the most relevant and important content to include in the curriculum. This may include textbook materials, articles, videos, and other resources.
3. Organize the content: Arrange the content in a logical and meaningful way, with a clear progression of topics and themes.
4. Design instruction and assessment: Create a plan for teaching the content, including the use of direct instruction, memorization, and practice. In addition, design assessments that measure student learning outcomes, such as multiple-choice tests, essays, and other forms of assessment.
5. Implement the curriculum: Put the curriculum into practice by training teachers, providing them with the necessary materials and resources, and monitoring the implementation process.
6. Evaluate the curriculum: Continuously evaluate the curriculum by evaluating the student's performance and collecting feedback from teachers, students, and other stakeholders. Use the data gathered to adjust and make improvements to the curriculum as necessary.

It is important to keep in mind that a knowledge-based curriculum is one of many approaches to curriculum design, and that there are other important elements to consider such as critical thinking, problem-solving, and creativity. Therefore, it should be considered that a balance between these elements has a comprehensive curriculum that serves the general objectives of education [31, 32].

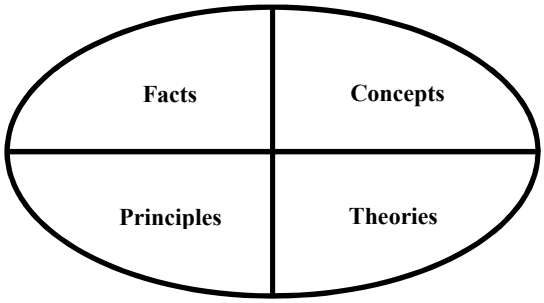

Figure 1: context of a knowledge-based curriculum

In the context of a knowledge-based curriculum, the differences between fact, concept ,principle, and theory may be somewhat like their meanings in science and research, but they may also have slightly different connotations. A fact in a knowledge-based curriculum is a piece of information that is well established and unchanging. It is a statement or data that can be verified or proven to be true, such as dates, events, people, and places. These are considered the fundamental building blocks of knowledge and understanding. A concept in a knowledge-based curriculum refers to a general idea or abstraction that is used to organize and understand related facts. Concepts are often more abstract and can be harder to define or explain in specific terms. They are considered as an essential tool for making connections and links between different pieces of information. A principle in a knowledge-based curriculum is a fundamental rule or law that explains how different concepts and facts are related. It is considered as a fundamental principle that provides the foundation of knowledge, and it is used to make predictions or draw conclusions about how things will behave in certain situations. A theory in a knowledge-based curriculum refers to a well-substantiated explanation of some aspects of knowledge that has been repeatedly tested and confirmed through observation and experimentation. Theories are well-established explanations, but like in science, it is still subject to change, or revision as new evidence is discovered [33, 34, 35].

In summary, a knowledge-based curriculum emphasizes building a strong foundation of factual knowledge, understanding of concepts, application of principles, and the ability to think critically and evaluate theories.

- *Approaches to Curriculum Design*

There are many different approaches to curriculum design, and different educational systems and institutions may use different approaches or a combination of approaches. The knowledge-based approach is just one of the possible approaches; it emphasizes imparting specific knowledge and skills [36, 37]. Some other approaches that are used in curriculum design include:

1. Define the desired learning outcomes: Identify the specific knowledge and skills that students should acquire because of the curriculum. This includes identifying the key concepts, facts, and information that students should learn, as well as the cognitive skills they should develop.
2. The child-centered approach focuses on the individual needs, interests, and abilities of students, and emphasizes student-centered learning and the use of hands-on, experiential methods.
3. The problem-based approach involves teaching through real-world problems and challenges, with the goal of helping students develop critical thinking and problem-solving skills.
4. The project-based approach emphasizes teaching through hands-on projects, with the goal of helping students develop creativity, collaboration, and other key skills.
5. The social constructivist approach emphasizes the importance of active learning and the role of

social interactions in the learning process. It is based on the idea that knowledge is constructed through social interactions and experiences.

6. The integrated Curriculum: It emphasizes the connection between subjects and the integration of subjects together. This approach aims to make learning more meaningful and relevant for students.
7. The Enquiry-Based Approach: It emphasizes student-driven learning, and the use of inquiry-based methods such as problem-based learning and project-based learning.

In summary, there are multiple approaches to curriculum design depending on the educational context; it might be a combination of different approaches to address the need of the students and the educational objectives [38].

- *Attributes of A Knowledge-Based Approach*

There are several attributes of a knowledge-based approach to curriculum design: Emphasis on specific knowledge and skills: The curriculum is designed to ensure that students acquire a specific set of knowledge and skills, such as facts, information, and cognitive skills like analysis, synthesis, and evaluation. The six attributes start with structured content: The content is carefully selected and organized, with a clear progression of topics and themes. This can include traditional textbook materials, as well as other resources like articles and videos. The second attribute is the direct instruction: The curriculum is taught through direct instruction methods, such as lectures and textbook readings, with the goal of transmitting knowledge to students [39].

Third attribute present in memorization and practice: The curriculum emphasizes memorization and practice, to help students acquire the specific knowledge and skills they need to learn. The Assessment attribute focus on recall: The curriculum is usually assessed through tests and quizzes that measure students' ability to recall and apply the knowledge they have learnt, such as multiple-choice, fill-in-the-blank, and other forms of testing. Forward to fifth attribute is Teacher-centered: The approach is teacher-centered, where teacher is the source of knowledge, who transmit and transmit this knowledge to the students, and the final attribute is emphasis on facts and data: The approach focuses on the acquisition of facts and data rather than understanding and interpretation [40].

It is worth to note, that the knowledge-based approach is often criticized for its lack of emphasis on critical thinking, problem-solving, and creativity, and for being too focused on the acquisition of information rather than on the understanding and application of it. Therefore, some educators argue that this approach can be seen as one element of a more comprehensive and holistic curriculum that addresses a variety of student needs and learning styles.

Traditional curriculums, which are often based on rote learning and memorization, can be seen as a barrier to innovation in education. These types of curriculums may not encourage critical thinking, problem-solving, or creativity, which are all important skills for fostering innovation. Additionally, traditional curriculums may not be as flexible in responding to new and emerging fields, technologies, or societal needs. On the other hand, some argue that a solid foundation of traditional knowledge and skills can be a necessary precursor for innovation. As such, there is a trade-off between how much to emphasize tradition and how much to emphasize innovation in curriculum design [41].

Overall, it is important that the curriculum adapts and evolves over time to keep up with changing societal needs and advances in technology. A balance between traditional and innovative elements may be the best approach for encouraging innovation in education.

3. LEARNING OUTCOME

The learning outcome in a curriculum is a statement that describes what a student should know or be able to do because of completing a course or program of study. It is a specific, measurable, and observable statement of what a student will be able to do at the end of a learning experience. Learning outcomes are usually written in terms of knowledge, skills, or attitudes that a student should possess or demonstrate. They are often used to align instruction with assessment, and to ensure that a course or program is meeting its goals and objectives [42].

There are several types of learning outcomes that can be included in a curriculum, and they generally fall into three main categories: (1) Cognitive: outcomes related to knowledge and mental processes, such as remembering, understanding, analyzing, and evaluating. (2) Affective: outcomes related to attitudes, values, and feelings, such as appreciation, respect, and valuing, and (3) Psychomotor: outcomes related to physical skills, such as observation, manipulation, and performing.

In practice, many learning outcomes will have elements of more than one of these categories. For example, a learning outcome for a physics course might require students to analyze and apply mathematical concepts to solve problems, which would involve cognitive and psychomotor skills.

Additionally, in demand to align with the Bloom's taxonomy of educational objectives which is widely used in education, the cognitive outcomes are further divided into 6 levels. Remembering, understanding, Applying, analyzing, evaluating, and creating Each level is generally considered more complex and abstract than the previous one. Thus, it's important to consider the level of learning outcome when aligning it with the instruction and assessment methods.

- *Relationship between knowledge-based approach and learning outcome.*

A knowledge-based approach to learning emphasizes the acquisition and retention of information, and it is closely tied to cognitive learning outcomes. When a curriculum is designed using a knowledge-based approach, the learning outcomes will typically focus on the student's ability to remember and understand information.

Learning outcome based on this approach is mainly associated with the Bloom's taxonomy's lower levels (Remembering and Understanding) which is closely related to the recall and comprehension of the information. Instructional methods that align with a knowledge-based approach include lectures, readings, and discussions, which are designed to transmit information to students, as well as assessment methods such as multiple-choice tests, fill-in-the-blank questions, and true/false questions which test the students' recall of information. It's worth noting that a sole knowledge-based approach is not always sufficient in education. Other approaches such as problem-based learning, inquiry-based learning, or even blended approaches that includes different methodologies are more preferred to align with the complexity of the real world and student's holistic development.

- *The National Qualification Framework Aspect, Knowledge-Based Approach and Learning Outcome.*

A National Qualifications Framework (NQF) is a system for organizing and describing educational qualifications in a country. It is used to ensure consistency and comparability in the design, delivery, and evaluation of education and training programs. In most countries, the NQF includes a set of learning outcomes that are associated with each level of education or training. These learning outcomes are generally aligned with the cognitive, affective, and psychomotor categories of the learning outcomes that I described earlier. When it comes to a knowledge-based approach, the NQF learning outcomes typically focus on the cognitive domain, specifically on the recall and comprehension of information. The NQF learning outcomes are associated with the lower levels of Bloom's taxonomy, such as remembering and understanding, and they usually require students to demonstrate knowledge and understanding of certain concepts, facts, and principles in a particular field of study.

It's worth mentioning that in most countries, NQF's are designed to take into account the need to provide learners with a broad and balanced education, which includes not only cognitive aspects, but also affective and psychomotor aspects. So usually, it is not limited to the knowledge-based approach, but it allows for other instructional methodologies as well. Additionally, the NQF often includes guidelines for the design and evaluation of education and training programs, which are intended to ensure that the programs meet the specified learning outcomes. These guidelines often include the use of assessment methods that align with the intended learning outcomes, such as multiple-choice tests, essays, or practical assessments, which are used to evaluate students' ability to recall, understand, and apply the knowledge.

A National Qualifications Framework (NQF) is a system for organizing and describing educational qualifications in a country. It is used to ensure consistency and comparability in the design, delivery, and assessment of education and training programs. In most countries, the NQF includes a set of learning outcomes that are associated with each level of education or training. These learning outcomes are generally aligned with the cognitive, affective, and psychomotor categories of the learning outcomes that I described earlier.

When it comes to a knowledge-based approach, the NQF learning outcomes typically focus on the cognitive domain, specifically on the recall and comprehension of information. The NQF learning outcomes are associated with the lower levels of Bloom's taxonomy, such as remembering and understanding, and they usually require students to demonstrate knowledge and understanding of certain concepts, facts, and principles in a particular field of study. It's worth mentioning that in most countries, NQF's are designed to consider the need to provide learners with a broad and balanced education, which includes not only cognitive aspects, but also affective and psychomotor aspects. So usually, it is not limited to the knowledge-based approach, but it allows for other instructional methodologies as well. Additionally, the NQF often includes guidelines for the design and assessment of education and training programs, which are intended to ensure that the programs meet the specified learning outcomes. These guidelines often include the use of assessment methods that align with the intended learning outcomes, such as multiple-choice tests, essays, or practical assessments, which are used to evaluate students' ability to recall, understand, and apply the knowledge.

- *National Qualifications Framework (NQF) with curriculum.*

The National Qualifications Framework (NQF) and curriculum are closely related in that they both play a critical role in shaping the design, delivery, and assessment of education and training programs. The NQF sets the standards for the education and training offered in a country and provides a structure for organizing the qualifications, typically into different levels, such as basic, intermediate, and advanced. The NQF also provides a set of learning outcomes for each level that specifies what students should know and be able to do because of completing a course or program of study.

The curriculum, on the other hand, is the specific set of courses and activities that are designed to help students meet the learning outcomes specified by the NQF. A curriculum is usually composed of a collection of learning experiences, resources, and assessments that are intended to help students acquire the knowledge, skills, and attitudes that are outlined in the NQF. The curriculum is the vehicle to achieve the learning outcomes that are established in the NQF. So, the NQF learning outcomes act as a guide for the curriculum designer to align the instructional methods, resources and assessments that are used in the curriculum. Curriculum designers can use the NQF learning outcomes to ensure that the education and training programs they design are consistent with the national standards and provide students with the knowledge and skills they need to progress to the next level of education or training.

In summary, the NQF sets the standards for education and training and provides a structure for organizing qualifications, while the curriculum is the set of courses and activities that are designed to help students meet these standards. Together, the NQF and curriculum work to ensure that education and training programs are of high quality, consistent and comparable across the country.

4. SKILLS

A skill is the ability to perform a specific task or activity in a competent and proficient manner. Skills can be categorized as either hard skills or soft skills. Hard skills are technical abilities or knowledge that can be quantified and measured, such as the ability to use a specific software program or knowledge of a particular subject. Examples of hard skills include Programming languages, Data analysis, Project management, foreign languages, machinery operation and medical procedures [43].

Soft skills are personal attributes or interpersonal abilities that are more difficult to quantify and measure, such as communication, problem-solving, and time management. Examples of soft skills include leadership, teamwork, communication, adaptability, time management, critical thinking, and creativity.

Both hard and soft skills are important for success in the workplace and in life. Hard skills are typically necessary to perform specific tasks and activities, while soft skills are necessary to interact effectively with others and navigate the social and emotional aspects of work and life.

Skills properties refer to the specific attributes or characteristics that define a particular skill. These properties can vary depending on the type of skill and the context in which it is used. Meanwhile, could be considered are (1) Knowledge: The theoretical background and information required to perform a skill. (2) Physical ability physical strength, coordination, and dexterity required to perform a skill. (3) Mental ability: The cognitive abilities, such as memory, attention, and problem-solving, required to perform a skill, and (4) Social ability is communication, collaboration, and leadership skills required to perform a skill [44].

The skill properties covered by complexity level of difficulty or sophistication required to perform a skill, transferability is extent to which a skill can be applied in different contexts or situations, Autonomy property is degree of independence required to perform a skill. Other properties are dynamism degree to which a skill requires adaptation or flexibility in response to changing circumstances finally, the creativity properties consider to degree to which a skill requires original thinking or innovation.

These properties can be considered when assessing, developing, and training skills. Understanding the properties of a skill can also help in identifying the most appropriate methods for teaching and evaluating that skill.

- *Skills Framework for the Information Age (SFIA)*

The Skills Framework for the Information Age (SFIA) is a framework that provides a common language and structure for describing and managing the skills and competencies required in the Information Age. It is a globally recognized framework that is used by organizations of all sizes and industries to identify, assess, and develop the skills of their workforce. SFIA has 7 levels of skills, from Foundation to Elite, and covers a wide range of IT and digital skills. It is intended to be used by organizations for workforce planning, skills development, and career progression, as well as for the development of training and certification programs. It is also used as a benchmark for IT roles and responsibilities [45].

The Skills Framework for the Information Age (SFIA) covers a wide range of IT and digital skills, which are grouped into six categories:

1. Strategy and Architecture: Includes skills related to enterprise architecture, IT strategy, and governance.
2. Change Management: Includes skills related to change management, project management, and program management.
3. Service Management: Includes skills related to service management, IT service continuity, and service design.
4. Solution Development: Includes skills related to solution development, software development, and testing.
5. Data Management: Includes skills related to data management, data governance, and data analytics.
6. Digital: Includes skills related to digital marketing, e-commerce, and digital transformation.

Each category is further broken down into subcategories, which are then divided into specific skills and competencies. Each skill is defined by its level of proficiency, which ranges from Foundation to Elite. The SFIA framework also includes a set of competencies that are considered essential for successful performance in any IT or digital role, such as problem solving, communication, and team working.

- *Skills framework for ICT in Singapore*

The Infocomm Media Development Authority (IMDA) in Singapore has developed a Skills Framework for Infocomm and Media (ICM) that provides a common language for describing and managing the skills and competencies required in the technology industry. The framework is intended to be used by employers, educational institutions, and individuals to identify, assess, and develop the skills needed for various roles in the industry. The ICM Skills Framework is divided into three levels:

1. Foundation: Basic skills and knowledge required for entry-level roles in the industry.
2. Specialist: Skills and knowledge required for more specialized roles in the industry.
3. Professional: Skills and knowledge required for professional roles in the industry.

The framework covers a wide range of IT and digital skills, including IT infrastructure, cybersecurity, data analytics, software development, digital marketing, and more. It is intended to be used as a benchmark for IT and digital roles and responsibilities, and to help employers identify the skills and competencies they need to support their workforce. The framework also helps individuals to identify their own skills and the qualifications they need to advance their careers in the technology industry.

- *Skills Roadmap*

A skills roadmap is a tool that can be used to determine an individual's current skills and identify areas for improvement. It is a plan that outlines the steps an individual need to take to acquire new skills or improve existing ones.

a. *Career skills roadmap:* This type of roadmap is designed to help individuals identify the skills they need to acquire to advance in their chosen field. It typically includes information on the specific skills required for different roles and the steps an individual needs to take to acquire them.

b. *Industry skills roadmap:* This type of roadmap is designed to help individuals identify the skills they need to acquire to be successful in a particular industry. It typically includes information on the specific skills required for different roles within the industry and the steps an individual needs to take to acquire them.

c. *Functional skills roadmap:* This type of roadmap is designed to help individuals identify the skills they need to acquire to be successful in a particular functional area such as marketing, sales, IT or finance.

d. *Personal skills roadmap:* This type of roadmap is designed to help individuals identify the skills they need to acquire in order to achieve their personal goals, such as learning a new language or developing a new hobby.

e. *Organizational skills roadmap:* Designed to align the skills of employees with the needs of the organization. It typically includes information on the specific skills required for different roles within the organization and the steps that need to be taken to acquire them.

f. Components Skills Roadmap: The components of a skills roadmap will vary depending on the context in which it is being used the six major components, the *current skills assessment* component is involves evaluating an individual's current skills and abilities to identify their strengths and areas for improvement. Which the second components are define the frame in component call *skills gap analysis* consider comparing an individual's current skills to the skills required for their desired job or industry to identify any gaps that need to be filled, where the component

development plan includes a list of specific skills and competencies that an individual needs to acquire or improve to reach their goal. It also includes a plan for how to acquire these skills, such as through training, education, or on-the-job experience.

The *Timeline* component is a skills roadmap that will often include a timeline for when specific skills or competencies will be acquired, refer to *Resources* component which skills roadmap will also include information on the resources available to an individual, such as training programs or educational opportunities. Finally, the *Evaluation* component aims regular evaluations to check the progress of the plan and adjust as needed.

Having a skills roadmap can help an individual to stay focused and motivated, and to make the most of their time and resources. It can also provide a clear path for advancement in their chosen field and increase their chances of success.

5. CROSS-CUTTING FACTORS KNOWLEDGE, LEARNING OUTCOMES, AND SKILLS

The curriculum life cycle refers to the process by which a curriculum is developed, implemented, and evaluated. Cross-cutting factors, knowledge, and learning outcomes are all key elements that are considered throughout this process. During the development phase of the curriculum life cycle, cross-cutting factors such as critical thinking and problem-solving are often integrated as core skills that are essential for students to develop as shown Figure.2.

Knowledge is a key focus during the development phase of the curriculum life cycle, as it forms the basis for what students will learn and be assessed on. The curriculum is designed to ensure that students acquire a broad range of knowledge and understanding in various subject areas. During the implementation phase of the curriculum life cycle, learning outcomes are used to guide instruction and assessment. These outcomes are often used to align instruction with the curriculum and to assess student progress and achievement.

Skills development is also a key focus during the implementation phase of the curriculum life cycle. Teachers use the curriculum to help students develop a wide range of skills, including both subject-specific skills and more general skills like critical thinking and problem-solving.

Finally, during the evaluation phase of the curriculum life cycle, data is collected and analyzed to assess the effectiveness of the curriculum. This includes assessing the extent to which students have achieved the intended learning outcomes, acquired the knowledge and skills, and developed the cross-cutting factors.

Based on this evaluation, adjustments can be made to the curriculum to improve its effectiveness for the next cycle. Overall, the curriculum life cycle is a continuous process that is designed to help students acquire the knowledge, skills, and cross-cutting factors that are essential for success in their future studies and career.

In Figure 3, the knowledge is the foundation of the NQF and curriculum, as it forms the basis for what students will learn and be assessed on. The NQF and curriculum are designed to ensure that students acquire a broad range of knowledge and understanding in various subject areas. Learning outcomes are specific goals or objectives that students are expected to achieve through their education. These outcomes are often used to guide the development of the NQF and curriculum, as well as to assess student progress and achievement.

Journal of Theoretical and Applied Information Technology
30th April 2024. Vol.102. No 8

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

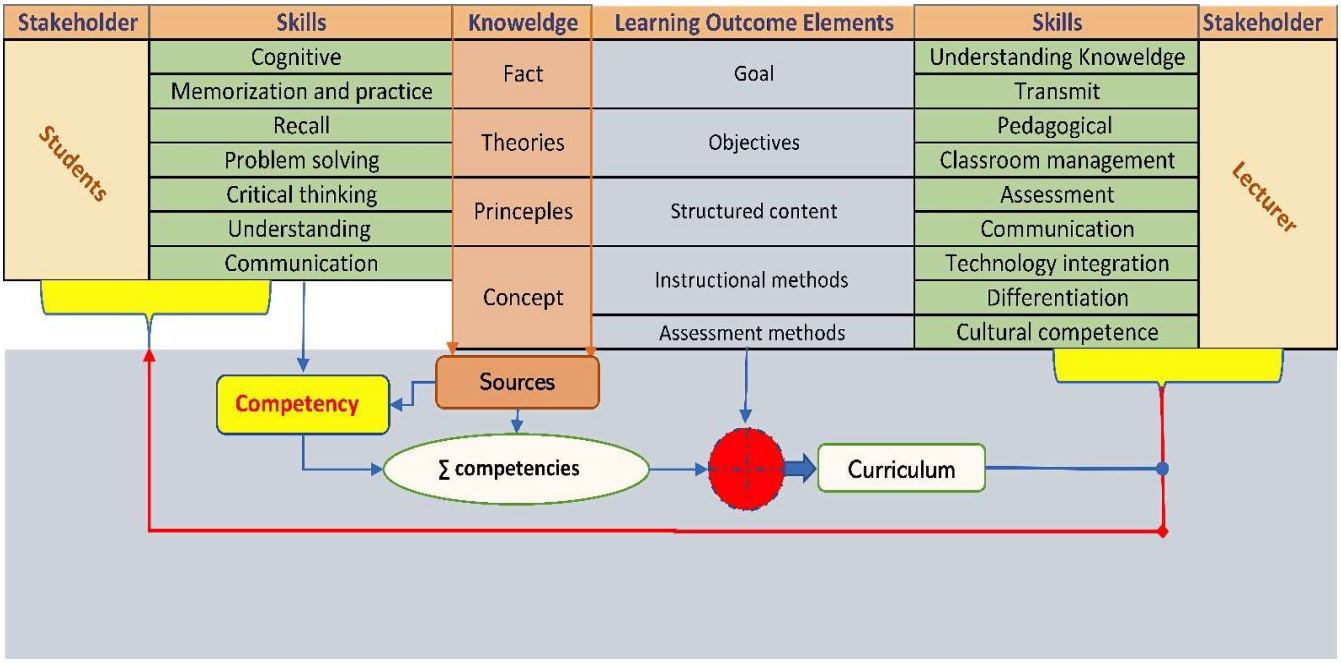

Figure 2: Cross-Cutting Factors Knowledge, Learning Outcomes, and Skills

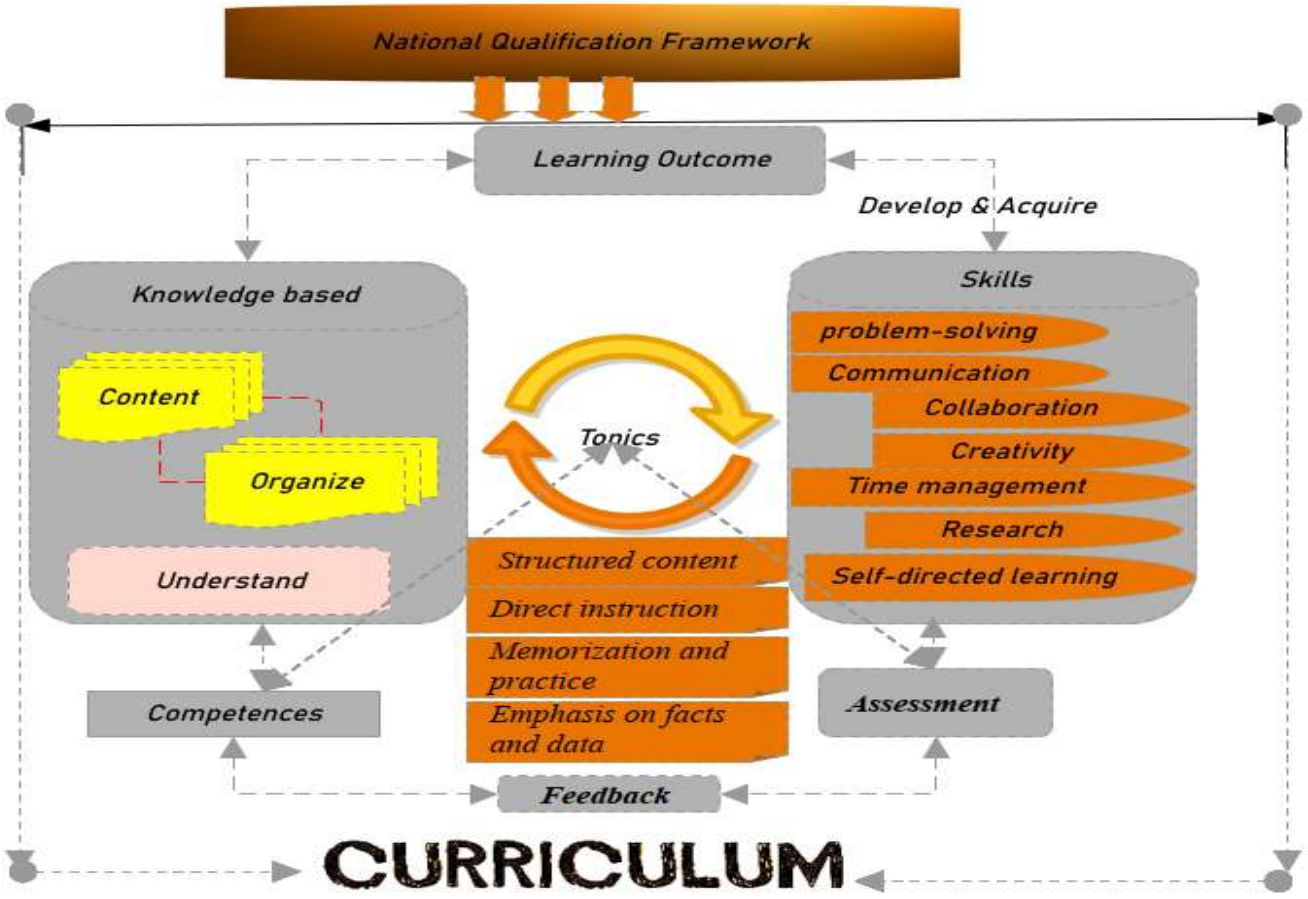

Figure 3: Knowledge-based, Learning Outcome and skills for NQF and Curriculum

The Figure above the knowledge is the foundation of the NQF and curriculum, as it forms the basis for what students will learn and be assessed on. The NQF and curriculum are designed to ensure that students acquire a broad range of knowledge and understanding in various subject areas. Learning outcomes are specific goals or objectives that students are expected to achieve through their education. These outcomes are often used to guide the development of the NQF and curriculum, as well as to assess student progress and achievement.

6. CONCLUSION

The National Qualifications Framework (NQF) is built on a knowledge base that encompasses a wide range of subjects and topics, tailored to correspond with varying levels of qualifications within the framework. The knowledge base required for basic or entry-level qualifications prioritizes foundational skills such as literacy and numeracy, while the knowledge base required for more advanced qualifications encompasses specialized or technical subject areas. Theoretical and practical knowledge, as well as specific skills and competencies related to the field of study, make up the composite knowledge base that underpins the NQF. This knowledge is acquired through a variety of educational experiences, including formal classroom learning, on-the-job training, or experiential learning opportunities. The primary objective of the knowledge base within the NQF is to equip learners with the requisite knowledge and skills necessary to excel in their chosen field of study or profession and facilitate their progression through different levels of education and training as they advance in their careers.

A knowledge-based curriculum emphasizes the acquisition and retention of subject-specific knowledge, skills, and understanding. It prioritizes a strong foundation in core subjects such as mathematics, science, English, and social studies, assuming that knowledge is the key to success and that students must possess a solid foundation in subject-specific knowledge to progress to higher levels of learning. In a knowledge-based curriculum, teachers play a crucial role in imparting knowledge to students and providing opportunities for them to apply their knowledge to real-world situations.

A knowledge-based learning outcome focuses on what students should know and understand after completing a course or program. The emphasis is on the acquisition and retention of specific knowledge and understanding related to a particular subject or discipline. Examples of knowledge-based learning outcomes include defining key terms and concepts related to the subject, explaining the significance of important events or developments related to the subject, and identifying patterns or relationships between different pieces of information related to the subject. A knowledge-based approach to learning outcomes can be useful for ensuring that students have a strong foundation in subject-specific knowledge, which can help them succeed academically and professionally. However, it is essential to balance this approach with other types of learning outcomes that focus on skills, attitudes, and other important aspects of learning.

REFERENCES

[1] OECD. (2018). The structure and governance of higher education of higher education systems. In Education Policy Outlook 2018: Putting Student Learning at the Centre. https://doi.org/10.1787/9789264301528-en

[2] BANTON, C. A. (2023). Development,(Dual) Citizenship and Its Discontents in Africa: The Political Economy of Belonging to Liberia. By Robtel Neajai Pailey. Cambridge: Cambridge University Press, 2021. 250p. 29.99 paper. Perspectives on Politics, 21(3), 1145-1146.

[3] GRAF, L. (2014). Growing in a Niche: Dual Study Programs Contribute to Change in Germany's Higher Education. WZB Report 2014, 33-36.

[4] DEISSINGER, T., & GONON, P. (2021). The development and cultural foundations of dual apprenticeships – a comparison of Germany and Switzerland. Journal of Vocational Education & Training,1-21. https://doi.org/10.1080/13636820.2020.1863451

[5] ERTL, H. (2020). Dual study programmes in Germany: blurring the boundaries between higher education and vocational training? Oxford Review of Education, 46(1), 79-95.https://doi.org/10.1080/03054985.2019.1687438

[6] Clark, S., Gallagher, E., Boyle, N., Barrett, M., Hughes, C., O'Malley, N., Ebuenyi, I., Marshall, K., & O'Sullivan, K. (2023). The International Education Index: A global approach to education policy analysis, performance and sustainable development. British Educational Research Journal,49(2),266-287. https://doi.org/10.1002/berj.3842

[7] Malnarich, G. (2005). Learning Communities and Curricular Reform: "Academic Apprenticeships" for Developmental Students. New Directions for Community Colleges, 2005(129), 51-62. https://doi.org/10.1002/cc.185

[8] Matsuo, M., & Tsukube, T. (2020). A review on cognitive apprenticeship in educational research: Application for management education. The International Journal of Management Education,18(3),1-9. https://doi.org/10.1016/j.ijme.2020.100417

[9] Suyitno, S., Kamin, Y., Jatmoko, D., Nurtanto, M., & Sunjayanto, E. (2022). Industrial Apprenticeship Model Based on Work-Based Learning for Pre-service Teachers in Automotive Engineering. Frontiers in Education, 7(865064), 1-12. https://doi.org/10.3389/feduc.2022.865064

[10] Reinders, H., Lai, C., & Sundqvist, P. (2022). The Routledge handbook of language learning and teaching beyond the classroom. Routledge.

[11] Memon, M. Q., Lu, Y., Yu, S., Memon, A., & Memon, A. R. (2022). The Critical Feature Selection Approach using Ensemble Meta-Based Models to Predict Academic Performances. INTERNATIONAL ARAB JOURNAL OF INFORMATION TECHNOLOGY, 19(3 A), 523-529.

[12] Al-momani, S. (2020). The Role of Yarmouk University in Reducing the Phenomenon of Unemployment from the Perspective of Graduate Students. Al-Zaytoonah University of Jordan Journal for Human and Social Studies, 1(1), 152-175.

[13] Society, A. f. C. M. A. a. t. I. o. E. a. E. E. I. C. (2001). Computing curricula 2001: Computer science.ACM.https://www.acm.org/binaries/content/assets/education/curricula-recommendations/ce-final-report.pdf

[14] Society, A. f. C. M. A. a. t. I. o. E. a. E. E. I. C. (2005). Computing curricula 2005: Computer science.ACM.https://www.acm.org/binaries/content/assets/education/curricula-recommendations/cc2005-march06final.pdf

[15] Society, A. f. C. M. A. a. t. I. o. E. a. E. E. I. C. (2013). Computing curricula 2013: Computer science.ACM.https://www.acm.org/binaries/content/assets/education/cs2013_web_final.pdf

[16] Society, A. f. C. M. A. a. t. I. o. E. a. E. E. I. C. (2014). Computing curricula 2014: Computer science.ACM.https://ieeecs media.computer.org/assets/pdf/CS2013-final-report.pdf

[17] Society, A. f. C. M. A. a. t. I. o. E. a. E. E. I. C. (2020). Computing curricula 2020 Paradigms for Global Computing Education. ACM. https://dl.acm.org/citation.cfm?id=3467967

[18] Hassan, M., & Al-Sadi, J. (2009). A New Mobile Learning Adaptation Model. International Journal of Interactive Mobile Technologies, 3(4). https://doi.org/10.3991/ijim.v3i4.986

[19] Dresden, C. o. C. (2023). Dual training - ways into the craft Take your future in your hands. https://www.hwk-dresden.de/Ausbildung/F%C3%BCr-Ausbilder-Betriebe/Duale-Ausbildung

[20] Reinhard, K., & Pogrzeba, A. (2016). Comparative cooperative education: Evaluating Thai models on work-integrated learning, using the German Duale Hochschule Baden-Wuerttemberg model as a benchmark. Asia-Pacific Journal of Cooperative Education, 16(3), 227-247.

[21] Bohlinger, S. (2019). Ten years after: the 'success story' of the European qualifications framework. Journal of Education and Work, 32(4), 393-406. https://doi.org/10.1080/13639080.2019.1646413

[22] Al-Shaikh, A., Shaheen, A., Al-Mousa, M. R., Alqawasmi, K., Al Sherideh, A. A. S., & Khattab, H. (2023). A Comparative Study on the Performance of 64-bit ARM Processors. International Journal of Interactive Mobile Technologies, 17(13).

[23] Alfauzan, A. A. H., & Tarchouna, N. (2017). The Role of an Aligned Curriculum Design in the Achievement of Learning Outcomes. Journal of Education and e-Learning Research, 4(3), 81-91.

[24] YOUNG, M. (2013). Overcoming the crisis in curriculum theory: a knowledge-based approach. Journal of curriculum studies, 45(2), 101-118. https://doi.org/10.1080/00220272.2013.764505

[25] Vergara, V., Lagos-Ortiz, K., Aguirre-Munizaga, M., Aviles, M., Medina-Moreira, J., Hidalgo, J., & Muñoz-García, A. (2016). Knowledge-Based Model for Curricular Design in Ecuadorian Universities Technologies and Innovation. CITI 2016, Guayaquil, Ecuador.

[26] Al-Shafei, H. (2022). Computerization of Programs for Teaching Arabic to non-native Speakers: Android Applications as a Model. Al-Zaytoonah University of Jordan Journal for Human and Social Studies, 3(special issue).

[27] Shaheen, A., Al-Sayyed, R., & Sleit, A. (2017). Improving visual analyses and communications

of ontology by dynamic tree (case study: computer system). International Journal of Advanced and Applied Sciences, 4(5), 62-66.

[28] Dimmock, C., & Goh, J. W. P. (2011). Transformative pedagogy, leadership and school organisation for the twenty-first-century knowledge-based economy: the case of Singapore. School leadership & Managment 31(3), 215-234. https://doi.org/10.1080/13632434.2010.546106

[29] Chan, T.-W. (1992). Curriculum tree: A knowledge-based architecture for intelligent tutoring systems International Conference on Intelligent Tutoring Systems (ITS1992), Montreal, Canada.

[30] Karameta, P. (2013). Switching from knowledge - based to competencybased curriculum Albania International Conference on Education, Tirana, Albania.

[31] Amarin, N. Z. (2020). The art of teaching in fusion classroom learning situations. International Journal of Innovation, Creativity and Change, 14(11), 11.

[32] Liu, T., Liu, H., Ni, W., & Si, M. (2023). Joint Extraction of Organizations and Relations for Emergency Response Plans with Rich Semantic Information Based on Multi-head Attention Mechanism. INTERNATIONAL ARAB JOURNAL OF INFORMATION TECHNOLOGY, Volume 20, pp. 880- 889 doi: 10.34028/iajit/20/6/5

[33] Schwab, J. J. (2015). The Teaching of Science as Inquiry. Bulletin of the Atomic Scientists, 14(9), 374-379. https://doi.org/10.1080/00963402.1958.11453895

[34] Ding, L., Chabay, R., & Sherwood, B. (2013). How do students in an innovative principle-based mechanics course understand energy concepts? Journal of Research in Science Teaching, 50, 722-747. https://doi.org/10.1002/tea.21097

[35] Alzyadat, W., AlHroob, A., Almukahel, I. H., Muhairat, M., Abdallah, M., & Althunibat, A. (2021, July). Big data, classification, clustering and generate rules: an inevitably intertwined for prediction. In 2021 International Conference on Information Technology (ICIT) (pp. 149-155). IEEE.

[36] Barrenechea, I., Beech, J., & Rivas, A. (2022). How can education systems improve? A systematic literature review. Journal of Educational Change, 1-21.

[37] Jebreen, I. (2017). E-learning System – Challenges & Barries: A Case Study. International Journal of Computing Academic Research, 6(2), 59-66.

[38] Boschman, F., McKenney, S., & Voogt, J. (2014). Understanding decision making in teachers' curriculum design approaches. Educational technology research and development, 62, 393-416.

[39] Amarin, N., & Al-Saleh, A. A.-S. (2020). The effect of color use in designing instructional aids on learners' academic performance. Journal of e-Learning and Knowledge Society, 16(2), 42-50.

[40] Assaraira, T. Y., Alhindawi, N., Bani-Mohammad, S., Al-Anber, Z. A., & Albashaireh, Z. A. (2022). The jordanian universities experience in integrating online learning and its quality assurance. Int. Arab J. Inf. Technol., 19(3A), 544-565.

[41] Hawashin, B., & Abusukhon, A. (2022). AN EFFICIENT COURSE RECOMMENDER USING DEEP-ENRICHED HIDDEN STUDENT APTITUDES. ICIC Express Letters, Part B: Applications, 1331-1338.

[42] Alazaidah, R.; Al-Shaikh, A.; R. AL-Mousa, M.; Khafajah, H.; Samara, G.; and Alzyoud, M. (2024) "Website Phishing Detection Using Machine Learning Techniques," Journal of Statistics Applications & Probability: Vol. 13: Iss. 1,Article8.DOI: https://dx.doi.org/10.18576/jsap/130108

[43] Maqableh, M., & Alia, M. (2021). Evaluation online learning of undergraduate students under lockdown amidst COVID-19 Pandemic: The online learning experience and students' satisfaction. Children and Youth Services Review, 128, 106160.

[44] Aljawawdeh, H. (2022). An Enriched e-Learning Model to Teach Kids in Arab Countries How to Write Code. International Arab Conference on Information Technology (ACIT), Abu Dhabi, United Arab Emirates, 2022.

[45] Brown, J. (2020). An examination of the Skills Framework for the Information Age (SFIA) version 7. International Journal of Information Management, 51, 102058.