🏆 *reviewed paper*

Diagnose Digital Skills Gap between Professional and Academic Sectors in Architecture Discipline – Jordan Case Study

Anwaar Banisalman, Ibrahim Marouf, Ali Abou Ghanimeh, Amira Fathi

(Arch. Anwaar Banisalman, Alexandria University, Faculty of Engineering, Alexandria, Egypt, anwar.salman@alexu.edu.eg)
(Prof. Dr. Ibrahim Marouf, Alexandria University, Alexandria, Egypt, ibrahim.maarouf@alexu.edu.eg)
(Prof. Dr. Ali Abou Ghanimeh, University of Jordan, ghanimeh@ju.edu.jo)
(Dr. Amira Fathi, Alexandria University, Alexandria, Egypt, arch.amira.aboelnasr@alexu.edu.eg)

1 ABSTRACT

There are many studies on digitization. The newly graduated engineer has a way of thinking, currency, and outlook on engineering work. Research on the ability of universities to graduate qualified architects for the professional market has become necessary to bring about changes in teaching methods and link them to digital programs. This paper looks at if there is a consensus between the opinion of professionals and academics about digital skills, trying to integrate urgent digital skills needed by the labor market in the Architecture education study plans.

Mixed between quantitative and qualitative research methods, researchers analyze the study plan of 12 universities, using the Curriculum Content Mapping)CMM(method, and conduct a questionnaire for academics and professionals. Accordingly, we prove the gap between the profession and the academic world in the discipline, and there is no agreement between them about the digital programs needed. Then researchers provide a matrix expressing the relationship between the digital courses and the AE courses in a way to connect the two.

Keywords: Study plan, Factor Analysis, Digital Architecture, Curriculum Mapping Method CMM, Architecture Engineering Education(AE)

2 INTRODUCTION

The study plans are linked to a set of competencies, transferring them to students to prepare competent engineers who can meet the needs of the labor market, and the most important of these competencies is the ability to work on digital programs, starting from thinking of the idea until preparing plans and then implementation. Researchers note that there is a gap between what architectural universities teach in Jordanian universities and the need for the labor market due to the tendency of many students to take reinforcement courses to improve their chances of obtaining a job.

2.1 Research Hypothesis:

There is a difference between the programs taught in universities and those needed by the professional market.

2.2 Methodology

This research used mixed techniques (quantitative and qualitative research methods). Firstly, to prove the gap quantitative method was used, depending on CMM; It is a technique used to explore how architectural knowledge is to be taught together with skills in curriculums, depending on the competency concept. (The Organisation for Economic Co-operation and Development, 2020)

(maart, Frantz, & Mphil, 2021) Use curriculum mapping to demonstrate the alignment of an undergraduate dental curriculum with a competency framework, and curriculum mapping revealed areas for improvement or gaps in the UWC dentistry curriculum's Afro MEDS competencies.

(Alshanqiti, Benaida, Alam, and Namoun, 2020) use the same method as a two-dimensional matrix expressing the relationship between the student's learning outcomes and the courses.

Secondly, to create the digital -course's network, researchers distributed questionnaire forms to professionals and academic architects and then analyzed the result using factor analysis and Cohen's weighted kappa in SPSS.

ISBN 978-3-9504945-2-5. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, H. R. KAUFMANN – Ljubljana, Slovenia

2.3 Goals and objectives

(1) The research aims to prove the existence of a difference between what architectural universities teach in the study plans in the field of architecture and the need of the labor market, especially technical programs.

(2) It also aims to provide a realistic touch of emergent programs in the era of digitization.

(3) Develop a network of relationships between teaching courses and digital programs that enhances the student's digital and architectural efficiency.

3 LITERATURE

3.1 Architecture Discipline in Jordan

According to JEA (Jordanian Engineers Association, 2021), unemployed engineers increased to 34% in 2021; Architects registered at JEA equal to 9% of the total engineers, while 38% of architects are unemployed, table 1.

Discipline	Total engineers that Able to work	A worker at offices and companies	Work outside the country	Un employee	Un employee percentage
Civil engineers	46265	21630	8750	15885	34 %
Architecture engineers	14436	6326	2559	5551	38 %
Mechanical engineers	31968	15952	6453	9563	30 %
Electrical engineers	57534	27540	11141	17955	31 %
Mining	1149	870	120	159	14 %
chemical	8284	4640	1877	1767	21 %
total	159636	76958	30900	50880	32%

Table 1: Unemployment rate in each engineering section. Source: JEA (Jordanian Engineers Association, 2021).

Graduated students mainly work in the following sectors: Private practices, large construction companies, the public sector, large industry organizations, or in the academic sector. The engineering sector was counting on job opportunities outside Jordan, but these opportunities seem to diminish over time (see Table 2). In the same manner, there is an increase in obtaining professional degrees between 2014-2020, as shown by Table 3.

YEAR	2012	2013	2014	2015	2016	2017	2018	2019	2020
Local Opportunities	1515	1809	1679	1888	1597	1320	685	1489	438
International Opportunities	1201	2399	4941	6209	2187	587	451	566	173
Total	2716	4208	6620	8097	3784	1907	1136	2055	611

Table 2: Job opportunities by JEA 2012-2020, 2020. Source: (Jordan Engineers Association, 2020).

	2014	2015	2016	2017	2018	2019	2020	TOTAL
Civil	1	22	61	59	64	90	64	361
Architecture	4	24	14	16	19	16	13	106
Mechanical	43	47	42	31	70	55	29	317
Electrical	24	50	37	30	85	61	42	329
Mining	----	---	10	1	3	6	1	21
Chimical	---	5	11	2	17	9	14	58
TOTAL	72	148	175	139	258	237	163	1192

Table 3: Engineers with professional degrees 2014-2020. Source: (Jordan Engineers Association, 2020).

The number of engineers working in engineering offices was (7971) in 2020, (5063) in design, (and 2908) in supervision. On the other hand, (8003) engineers worked in 2019, (5004) in design, and (2999) in site supervision, with a drop ratio were (0.4%).

3.2 Digital Skills in the Professional Market

(Khodeir & Nessim, 2020) evaluated the level of importance of the graduate skills, they found that responsibility, positive attitude, and researchers rate teamwork as the top. However, (Salleh, Md Yousof, & Momon, 2016) in their research highlighted that the quality of graduates evaluated through technical and non-technical skills. Employers in the professional world usually seek other skills apart from the technical skills gained during undergraduate studies in architecture schools. Correspondingly, there is a high demand for architects with the skills to manage real projects. Those skills are not limited to planning and designing but also include diverse employability skills, including critical thinking, teamwork, leadership, and

negotiation. Also, (Khodeir & Nessim, 2020) evaluated the importance of graduate skills; they found that responsibility, positive attitude, and teamwork skills were at the top.

Figure :1 advertisements examples for demand skills in Jordan professional market, source: architects of Amman-facebook group.

3.3 Digital Skills in Architecture Education

The standard architectural curriculum incorporated design studio as the center subject; the teaching happens within the studio, and the other basic abilities are design theory, history, visual communication, and representation, building innovation. The researchers divided the educational environment into two main titles: "distance education" and "formal education." Formal education environments are varied, such as classrooms, workstations (cluster, group), and one-by-one interactive and educational tools, such as traditional and digital tools. (Yıldırım, Yavuz, & Kırcı, Experience of traditional teaching methods in architectural design, 2012),researchers illustrate that teachers manage design studios in both a "teacher-oriented" and "student-oriented" manner in terms of the method.

Moving toward new teaching methods in the architectural design studio is a need as (Ciravoğlu, 2014) and (Walter & Rangaswamy, 2014) mentioned: “By bringing technology into the classroom and by doing complex and realistic problems, we can make our classes livelier and relevant.” (Saghafi, Mozaffar, Moosavi, & Fathi, 2015)

Mention two techniques in architecture teaching which are the teaching method with the creation of the Design Studio and the free-Hand Drawing Teaching Method as insured by (Tepavčević, 2017), "rethinking of models for design-led research provides a new framework for design pedagogy that responds to technological shifts and new design thinking."

Rivka Oxman (2006), in her paper "Theory and Design in the first digital age," proposed a theory of digital design that tried to map the different levels of interaction of the user with digital media and integration of the computer into the design. Oxman identified four components of digital design - representation, generation, evaluation, and performance - specified performance (Oxman, 2006).

4 FINDING AND DISCUSSION

Digital technology changed the way we teach and learn architecture, even digital design courses or standalone courses. Digital technology, such as the virtual design studio, many architectural schools introduce a new method of teaching architectural design. Focusing on the fact that computerized design education plays a significant part in tomorrow's architectural education, the curriculum developer can create computerized substance into a platform in the modern architectural curriculum.

By Analyzing Jordan universities’ study plans researcher aims to know the standing-alone computerized courses, and digital design courses in Jordanian education as shown in Table 4.

4.1 Curriculum Content Mapping (CCM) Results

	Name of Universities	Credit hours	Computerized courses		Digital design courses	
			CREDIT HOURS	PERCENTAGE	CREDIT HOURS	PERCENTAGE
1	University of Jordan	178	10	5.6%	3	0.01%
2	Hashemite University	172	10	5.8%	0	0 %
3	AlbalqaApplied University	166	10	6%	0	0 %

ISBN 978-3-9504945-2-5. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, H. R. KAUFMANN – Ljubljana, Slovenia

4	Philadelphia University at Jordan	165	10	6%	3	0.01%
5	AlAl-Bayt University	165	9	5.4%	0	0 %
6	Muta University	172	14	8%	0	0 %
7	Al Ahliyya Amman University	165	11	6.6%	0	0 %
8	Zarqa University	167	12	7.1%	0	0 %
9	Amman Arab University	169	7	4%	0	0%
10	Al Isra Private University Amman	169	10	5%	0	0 %
11	Al Ahliyya Amman University	165	11	6%	0	0%
12	Al Yarmouk university	167	6	3.5	0	0%

Table 4: Credit hours and computerized courses in the study plan at the sampling universities. Source: Researchers.

(5.4 -8 %) the study plan in AE are separate courses that teach computer science as stand-alone courses; (BIM,2DCAD,3D CAD, C++, GIS), and there are no digital courses except in two universities, the University of Jordan and Philadelphia University.

Those numbers do not mean that universities do not use several programs in the educational process. However, they use them in a non-programmed way that differs from one teacher to another according to the instructor's efficiency.

4.2 Questionnaire Results

The researchers sent the statistical survey digitally to 32 professional and 16 curriculum developers; the survey consisted of three items, and the value of Cronbach's alpha for the survey α= 0.9, as shown in Table 5.

		Asymptotic			95% Asymptotic Confidence Interval	
Ratings	Weighted Kappa	Std. Error	z^c	Sig.	Lower Bound	Upper Bound
academic - professional	-.061	.073	-.713	.476	-.205	.083

Table 5: Cohen's Weighted Kappa using SPSS.Source: Researchers.

In general, by asking professionals and academics to rank the programs, we found that:

To professionals, REVIT is the most important, then Sketch up, Photoshop, 3DMAX, GIS, GRASSHOPPER, and finally, the least important are BIM and RYNO, but in the academic sector CAD is the most important program, as is 3DMAX, and finally REVIT. By asking about essential programs according to job requirements, we found that: Private architects, Large construction companies, Public sector bodies, Academic sector differ in their needs, as Table 6 shows.

On average private architects prefer 3DMAX, BIM, GRASSHOPPER, AND RYNO. Large construction companies need GIS,3DMAX, GRASSHOPPER, and RYNO. Public sector-governmental: prefer GIS. The academic sector emphasizes CAD and REVIT.

Competence	Role	Private architect practices	Large construction companies	Public sector bodies	Academic sector
Media and Visualization skills	BIM	3	4	4	1
	CAD	4	3	4	4
	GIS	2	2	3	3
	3DMAX	3	2	2	2
	REVIT	4	4	4	4
	GRASSHOPPER	3	2	2	2
	RYNO	2	2	2	3
	PHOTOSHOP	3	3	4	3
	Average rank	3	2	3	4

Table 6 categorizes the digital program by job role. Source: Researchers.

The researchers found no consensus between the academic and professional points of view about the digital programs needed; this ensures the gap between the professional and academic sectors.

By asking to interrelate digital programs into courses: Academic architects arrange digital programs integrated into curriculum courses. Also, professionals give their views, and then the researcher conducts factor analysis using SPSS to discover the pattern of digital programs and explore how it interacts with other courses. Researchers conclude the following model,figure 2.

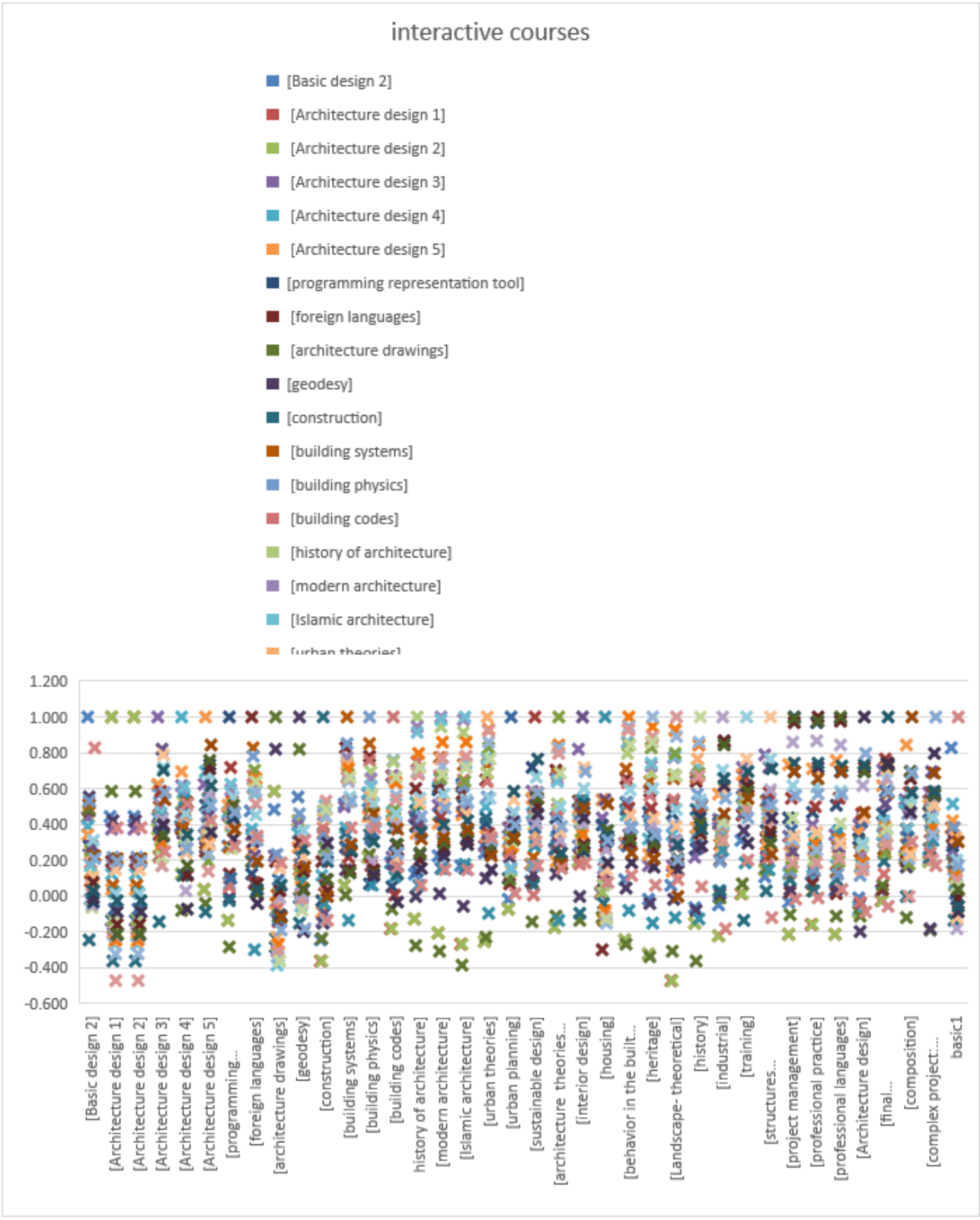

Figure (2): Horizontal and vertical relations between courses group. Source: Researchers.,using factor analysis in SPSS

The researchers noted from tables 7-12 that the participants suggested the link between electronic programmes in the educational process at different levels. However, most agreed that cad and sketch can integrate with all courses; it is appropriate to filter which programmes are more useful and include them in the study plans. The multiplicity of programmes may be helpful to be in harmony with the labour market's needs and the times requirements, where decision makers form a flexible framework for digital competencies.

ISBN 978-3-9504945-2-5. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, H. R. KAUFMANN – Ljubljana, Slovenia

RYNO	basic 1
	architecture design 4
	architecture design 5
	geodesy
	construction
	modern architecture
	islamic architecture
	urban theories
	sustainable design
	architectural theories and critique

PHOTOSHOP	basic 1
	[programming representation tool]
	architecture drawing
	[building codes]
	[history of architecture]
	[modern architecture]
	[Islamic architecture]
	[urban theories]
	[architecture theories and critique]
	[behavior in the built environment]

GRASSHOPPER	[programming representation tool]
	[foreign languages]
	[geodesy]
	[building systems]
	[sustainable design]
	[architecture theories and critique]

Table :7 Course–RYNO program relation. Source: Researcher. Table 8: Course–PHOTOSHOP program relation. Source: Researcher. Table 9: Course–GRASSHOPPER program relation. Source: Researcher

REVIT	[Architecture design 1]
	[Architecture design 2]
	[Architecture design 3]
	[Architecture design 4]
	[Architecture design 5]
	[foreign languages]
	architecture drawing
	[construction]
	[building systems]
	[building physics]
	[building codes]
	[urban theories]
	[urban planning]
	[sustainable design]
	[architecture theories and critique]
	1 [interior design]
	[housing]
	[behavior in the built environment]
	[heritage]
	[Landscape- theoretical]
	[history]
	[industrial]
	[training]
	structures &construction]
	[project management]
	[professional practice]
	[professional languages]
	[Architecture design6]
	[final project :architecture, structure, urban, landscape design]
	[composition]
	[complex project: architecture engineering]
	islamic architecture
	modern architecture
	history

GIS	[Architecture design 5]
	[programming representation tool]
	[foreign languages]
	architecture drawing
	[geodesy]
	[construction]
	[building systems]
	[modern architecture]
	Islamic architecture
	[urban theories]
	[urban planning]
	[sustainable design]
	[architecture theories and critique]
	[interior design]
	[housing]
	[behavior in the built environment]
	[heritage]
	[Landscape- theoretical]
	[history]
	[industrial]
	[training]
	[project management]
	[professional languages
	[final project :architecture, structure, urban, landscape design]
	[composition]
	[complex project: architecture engineering]
	[building physics]

GIS	[Architecture design 5]
	[programming representation tool]
	[foreign languages]
	architecture drawing
	[geodesy]
	[construction]
	[building systems]
	[modern architecture]
	Islamic architecture
	[urban theories]
	[urban planning]
	[sustainable design]
	[architecture theories and critique]
	[interior design]
	[housing]
	[behavior in the built environment]
	[heritage]
	[Landscape- theoretical]
	[history]
	[industrial]
	[training]
	[project management]
	[professional languages
	[final project :architecture, structure, urban, landscape design]
	[composition]
	[complex project: architecture engineering]
	[building physics]

Table 10: Course–REVIT program relation. Source: Researcher. Table 11: Course–GIS program relation. Source: Researcher. Table 12: Course– BIM program relation. . Source: Researcher.

5 CONCLUSIONS

(1) Researchers expect that the findings and discussion help AE programs evaluate their current study plans for Jordanian universities, as we conclude:

(2) There needs to be a consensus between the academic and professional points of view about the digital programmes needed that ensure the gap between the two.

(3) Emphasize using digital tools in architectural courses.

(4) It is necessary to study and develop study plans from time to time to achieve a higher level of the graduated architect who can work and keep pace with changes in the era of digitization.

(5) During curriculum development, it is essential to consider the stakeholder's views.

(6) There is a must to integrate courses with digital programs to enhance professional skills.

(7) Some digital programs are emerging according to the era's demand, and curriculum developers must consider them in AE study plans, such as BIM, RYNO, and GRASSHOPPER.

(8) The job market in Jordan needs trained workers who graduate from educational institutions and who need more advanced technology produced by educational institutions and for research that leads to increased production and improvement of its quality

(9) Teachers must integrate digital educational software, interactive learning, virtual schooling, and online education to simulate the learning process.

(10) The framework that AE schools require expands on the Core Curriculum while incorporating new components like Mandatory Competencies and Career Role Levels.

(11) Researchers ensure the importance of reconsidering the engineering programs that are taught based on the needs of the practice market. Moreover, specify the most critical programs that new engineers should master.

One of the study outputs is a contextual framework that aims to provide a theoretical basis from which to understand and empirically establish a common language for describing domain-specific epistemic beliefs in architecture education to globalize the plan of work, figure (3) take the following actions:

Demand analysis:

(1) To specify emerging architect characteristics and skills from a professional point of view.

Supply analysis:

Analyses the current curriculums based on selected competence models or accreditation board standards.

To extract specifications that form the study plan guidelines from the stakeholder's point of view.

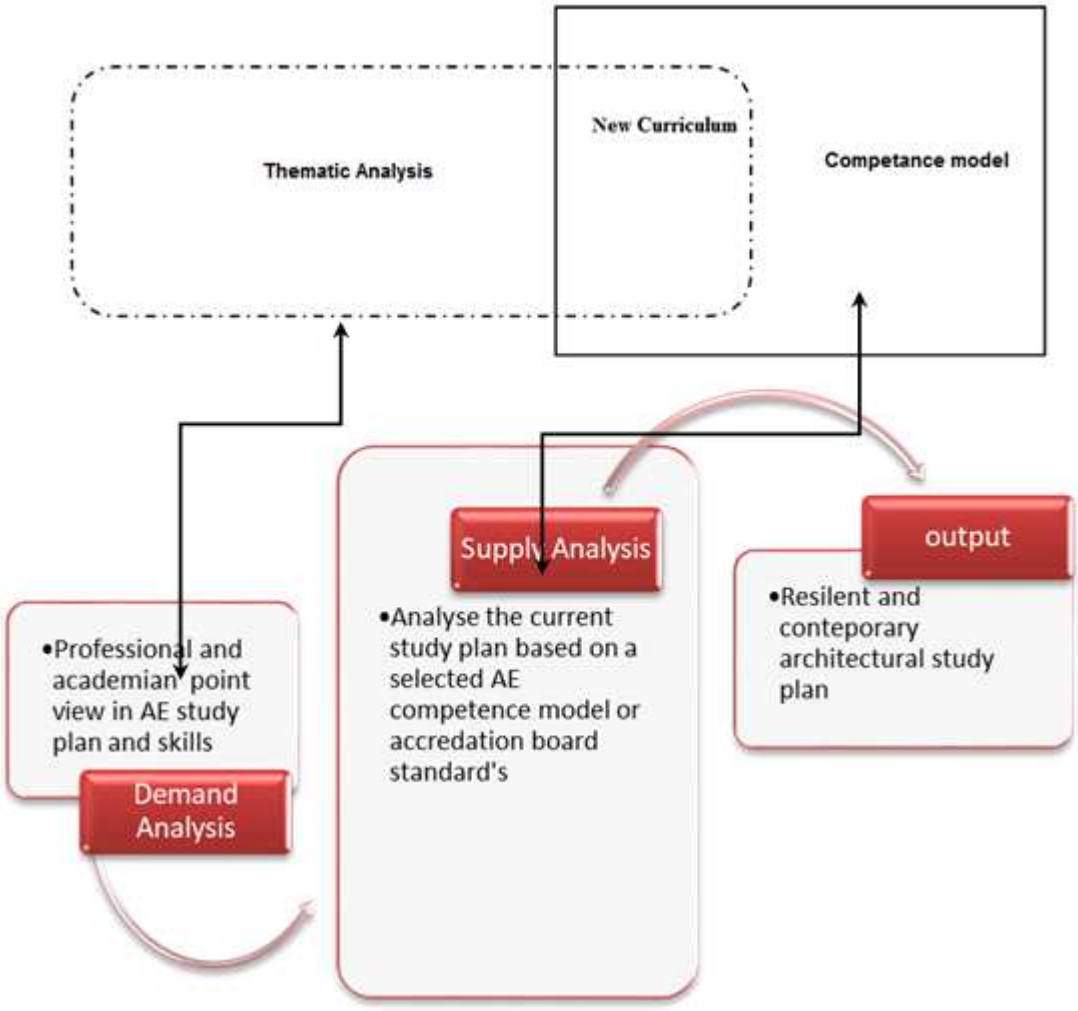

Figure 3: plan of contextual model.Source: Researcher.

6 REFERENCES

RIBA. (2018). International Schools with courses recognized.

Al-Matarneh, R., & Fethi, I. (2017). Assessing The Impact Of Caad Design Tool. Malaysian Online Journal of Educational Technology, 5(1).

AL-QAWASMI, J. (2004). REFLECTIONS ON E-DESIGN: THE E- STUDIO EXPERIENCE. 1st ASCAAD International Conference, e-Design in Architecture (pp. 177-193). Dhahran, Saudi Arabia: : https://www.researchgate.net/publication/30867319.

Alshanqiti , A., Benaida, M., Alam, T., & Namoun, A. (2020). International Journal of Advanced Computer Science and Applications, Vol. 11(No. 12).

Bashabsheh, A., Alzoubi, H., & Ali, M. (2019). The application of virtual reality technology in architectural pedagogy for building constructions. Alexandria Engineering Journal, 58, 713-723.

ISBN 978-3-9504945-2-5. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, H. R. KAUFMANN – Ljubljana, Slovenia

Boyd, D., & Thurairajah, N. (2015). Construction Education in the New Digital World. Birmingham City University. Birmingham UK: RESEARCH GATE.
Bruffee, K. (1999). Collaborative Learning: Higher Education, Interdependence, and the Authority of Knowledge. The Journal of Higher Education, 66(4), 483-485 .
Ciravoğlu, A. (2014). Notes on architectural education: An experimental approach to. Social and Behavioral Sciences, pp. 7 – 12.
Gerber, B., Gerber, D., & Ku, K. (2011). THE PACE OF TECHNOLOGICAL INNOVATION IN ARCHITECTURE, ENGINEERING, AND CONSTRUCTION EDUCATION: INTEGRATING RECENT TRENDS INTO THE CURRICULA. (T. Z, Ed.) Journal of Information Technology in Construction, 16, 411-432.
GROSS, M., & YI-LUEN DO, E. (1999). Integrating Digital Media in Design Studio. Proc. ANational Conference '99 (Minneapolis, Minn). CSA (American Collegiate Schools of Architecture).
House, R. (1994). Webster's New Universal Unabridged Dictionary: Fully Revised and Updated. New York: Barnes and Noble.
https://www.statista.com/statistics/385565/unemployment-rate-in-jordan. (n.d.).
Jordan Engineers Association. (2020). JEA Magazine. Engineering education and the job market, 88.
Jordanian Engineers Association. (2021). Unemployment in the engineering sector. Jordanian Engineers Association.
Kensek, K. (n.d.). Visual Programming for Building Information Modeling: Energy and Shding Analysis Case Studies. Journal of Green Building, 10(4).
Lang, J. (1987). New York: Van Nostrand Reinhold.
lynn, G. (1999). Animate Form. Princeton Architectural Press.
maart, R., Frantz, J. M., & Mphil, A. R. (2021). Curriculum mapping: A tool to align competencies in a dental curriculum. Vol. 13(No. 2). doi:10.7196/AJHPE.2021.v13i2.1257
Makaklı, E. (2019). STEAM approach in architectural education. ERPA International Congresses on Education , 66(SHS Web Conf).
MAO-LIN, C. (2006). THE JUMP OF DIGITAL DESIGN THINKING.
Ministry of Higher Education and Scientific Research . (2012/2013). Ministry of Higher Education and Scientific Research statistics in Jordan. Ministry of Higher Education and Scientific Research .
Monsur, M., & Islam, Z. (2014). GIS for Architects:Exploring the Potentials of IncorporatingGIS in Architecture Curriculum. ARCC/EAAE 2014 | Beyond Architecture: New Intersections & Connections. Manoa : University of Hawaiá.
Oxman, R. (2006). Theory and design in the first. Design Studies, 27, 229-265.
OXMAN, R. (2010). Theory and design in the first digital age. DESIGN DTUDIES, pp. 229-265.
Parasonis, J., & Jodko, A. (2013). Competence Model for the Architectural Engineering Professional. PROCEDIA ENGINEERING, pp. 876-881.
Riccobono, A. (2014). Architectural design in the digital era,identifying computer influence and new experessive trends in current architecture. Università degli Studi di Palermo.
Sacks, R., Eastman, C., Lee, G., & Teicholz, P. (2018). BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers. John Wiley & Sons.
Saghafi, M., Mozaffar, F., Moosavi, S., & Fathi, N. (2015). Teaching Methods in Architectural Design Basics. Ciência eNatura, 37(1), 379−387.
Schon, D. (1992). The Reflective Practitioner: How Professionals Think In Action Paperback. London: Routledge.
Soliman, S., Taha, D., & Sayad, Z. (2018). Architectural education in the digital age. Alexandria Engineering Journal, 809–818.
Tamimi, A. (2015). Higher Education in Jordan: Crisis & Opportunities. The Fifth PRME MENA FORUM. Amman.
Tepavčević, B. (2017). Design thinking models for architectural education. The Journal of Public Space, 2(3), 67-72.
The Organisation for Economic Co-operation and Developmen. (2020). Technical Report: Curriculum Analysis of the OECD Future of Education and Skills 2030. OECD.
Uskov, V., & Howlett, R. (2016). Smart Education and Elearning 2016. (L. Jain, Ed.) SPRINGER.
Walter, T., & Rangaswamy, A. (2014). TEACHING METHODS FOR HIGHER EDUCATION. Dept. of Management Studies, Infant Jesus College of Engineering.
Wastiels, L., & Wouters, I. (2008). Material Considerations in Architectural Design:. Design Research Society Conference.
Yıldırım, T., Özen Yavuz, A., & Kırcı, N. (2012). Experience of tradiational teaching methods in architectural designeduacation: "mimesis technique". Procedia social and behaviour science, pp. 234-238.
Yıldırım, T., Yavuz, A., & Kırcı, N. (2012). Experience of tradiational teaching methods in architectural design. Social and Behavioral Sciences, 51, pp. 234 – 238.