# Smart Curriculum Mapping and Its Role in Outcome-based Education

Tanweer Alam[1], Mohamed Benaida[1]
[1]Faculty of Computer and Information Systems, Islamic University of Madinah, Madinah, Saudi Arabia
E-mail: tanweer03@iu.edu.sa, md.benaida@gmail.com

**Keywords:** Curriculum mapping, Student learning outcomes, Assessment Methods, Machine Learning Techniques, K-Map Algorithm.

**Received:** September 1, 2021

*Educational development processes are essential for successful academic performance in educational and technical environments. Teachers and students also need a model and guidelines required for effective learning. Without effective curriculum mapping, the institutions cannot accurately estimate outcomes and maximize potential performance on resources. A matrix depicts the relationship between student learning outcomes (SOs) and topics on the curricular map. The need to earn satisfying produce of education and achieve considerable progress in the visibility of education equity in completing professional duties is a primary motivation for learning the curriculum. One of the most effective strategies to increase overall teaching effectiveness, involvement, or curricular interaction is curriculum development. The mapping connects all disciplines to academic outcomes and displays well-planned teaches. An excellent example of a curriculum should be well-prepared and purposefully encourage expertise acquisition. This paper describes a set of range standards and recommendations for this technique and challenges that affect curricular map construction. As a result, this strategy will increase the overall performance of education and the quality of the curriculum.*

*Povzetek: Prispevek opisuje novo arhitekturo veriženja IBchain, ki uporablja internet stvari in verigo blokov za varno komunikacijo*

## 1 Introduction

Curriculum maps offer data that display how essential curriculum parameters are related and aligned. The mapping with the parameters at the upper left and down the proper columns regularly reflects it. Then, at some stage in the essential cells, association signs signify relation to some of the vital issue additives, using a curriculum mapping model to demonstrate where results are interpreted via courses. Curriculum mapping is a program that has proven to be effective. Within the current phase of innovative system recommendations, it is widely utilized as a monitoring mechanism in better education. It gives program directors and teacher guides the ability to regularly direct their curriculum files and obtain outcomes data [1]. Educational institutions have established curriculum mapping solutions to increase program quality, participation, and collaboration. Such methodologies can effectively assist college students in understanding curriculum results and identifying problems in the functions [2]. Curriculum mapping is a term used to describe the process of controlling syllabus learning outcomes using guidelines to identify or highlight academic discrepancies, inefficiencies, and inconsistencies in conceptual curriculum results [3]. The outcomes include improving the syllabus map's standard alignment and more significant student learning outcomes [4]. Furthermore, the curriculum map style indicates how well the issue educator will illustrate, and the content structure will cover the teaching principles established by professional learning outcomes [5]. As a result, experts have developed an intelligent solution, including a current curriculum map as an addition that allows us to explore road maps, increase efficiency, and offer recommendations for refining the lesson map (Figure 1). Our goal is to create a platform that intelligently carries out the program's instructions and skilled outcomes. Accreditation organizations approve curriculum courses following the plan's educational aims and the position's requirement for a curriculum map to determine the effectiveness of each resource / expert outcome.

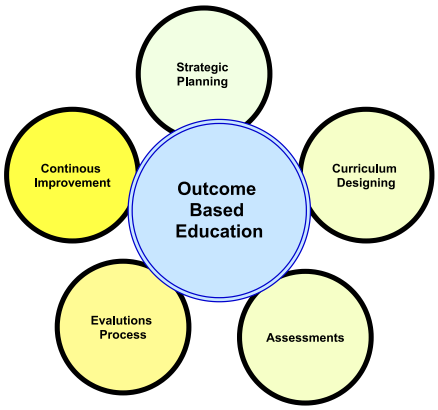


Figure 1: Outcome-based education tools

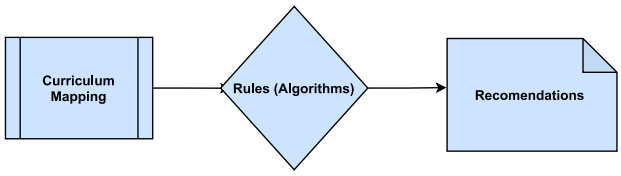


Figure 2: Smart Curriculum Mapping Process

The following research questions are suggested as part of this study:

1. What are the most successful ways for locating a functional map in a curriculum?

2. How will we include such procedures into the intelligent map reaction?

The standard exceeds the following measures, special curriculum map assessment presented.

1. Describe the syllabus's topics and learning outcomes for each problem.

2. To satisfy the program's needs, write measurable learning outcomes for learners. Several platforms, such as ABET, receive findings from accredited authentication organizations.

3. professional program outcomes with a healthy education. This alignment should be as precise as feasible to aid in the full achievement of student learning outcomes.

4. Check the curricular map using a set of expertise rules. The initial level of a curriculum map is evaluated using this set of guidelines.

5. Instructions for creating and revising curricular maps to improve fundamental learning skills. A few tips, for example, are unrelated to a broad publishing style relating to software outcomes or additional learning after appearance.

The curriculum mapping evaluation is completed in the following stages.

Stage 1. Self-study strategic planning for each course in a program. Figure 2 shows the smart curriculum mapping process.

Stage 2. Writing good student learning outcomes for fulfilling all requirements of a program.

Stage 3. Align the courses with standard students learning outcomes.

Stage 4. Apply the intelligent algorithm to evaluate the curriculum mapping.

Stage 5. Find all recommendations from the algorithm and rebuild the curriculum mapping to improve the quality of learning.

This material is divided into the sections below. The second section depicts activities connected to curricular mapping; the third section details the methods and rules for refining the map; the fourth section describes the proposed algorithm. The fifth section displays and discusses the findings of the issues. Finally, section 6 brings the work to a close with recommendations for further research.

# 2 Related works

Plaza et al. (2007) published a paper on curriculum mapping and application evaluation. The authors have combined work with students and teachers with a picture relevant to the curriculum mapping in this research [6], which shows the correlation between motivated/enhanced and acquired ideas.

Uchiyama and Radin (2009) published articles on curriculum mapping for better learning. They represent a curriculum map that can develop recognition based on real-time data to improve school education quality [7].

Perlin (2011) stared at the curricular map for this evaluation program, solely centred on using the George Mason University Fitness Management Method. It aided in developing a framework for integrating high-level analysis with a mapping exercise. This framework begins with acquiring analytical and technical methods to study the university's mapping approach and applications.

As a result, interruptions have emerged. It has been discovered that they can be adaptable in the end, and users can grasp how to overcome those challenging conditions, so learners of this mapping gadget should develop the first college software [8].

Spencer et al. (2012) provided a curricular map related to the possibility of adjusting. The collecting, assessment, and innovative exercise and evaluation skills are discussed. This method of questioning encourages the growth of physical exercise collaboratively. Incremental graphs provide conceptual presentations of essential techniques and requirements [9].

Lam and Tsui have presented a research article on course mapping experiments. (2013). It suggests that creating a curriculum map could be a good technique for determining how much agreement university students have in producing results that fit the expectations. It means that developing a curriculum map could be a valuable tool for assessing the level of agreement among university students in creating outcomes that correspond to the university organization's learning [10]. Although the use of mathematics in a better university is promising, Avela et al. (2016) believe that the best errors are related to the sharper development of examination statistics in the concern that consumers would be unable to use this system successfully or with its measureless interval. As a result, academics have looked into scientific intelligence-sharing methodologies for visual data analysis, relationship mining, and other issues. As a result, the advantages and problems of acquiring scientific knowledge have been identified and recognized for better education, allowing educators to use this powerful and effective tool to enhance the happiness of learning in a better education [11].

Pat Hutchings (2016) presented a paper on the focus of education and the student's outcomes. It focuses on identifying and spreading approaches for applications and organizations to effectively use assessment data to notify and improve courses and convey satisfactorily with candidates [12].

A research article on advanced program progress processes was published by M Jacobsen et al. (2018).

| | Basic Courses | Compulsory Courses | Compulsory Courses | Compulsory Courses | Compulsory Courses | ---- | Capstone Course |
|---|---|---|---|---|---|---|---|
| SO-1 | I | R | R | | R | -- | E |
| SO-2 | I | | | R | R | -- | E |
| SO-3 | I | | R | R | | -- | E |
| SO-4 | I | | | R | R | -- | E |
| SO-5 | I | R | | | R | -- | E |
| SO-6 | I | | | R | R | -- | E |
| ------- | I | R | R | R | | -- | E |

Table 1: Curriculum Matrix (Model)

They have presented the continuous development methods based on flexibility and assistance, occurring in a program led by an annual organization headed by organized platforms [13].

The usage of the curriculum map in the modern science school has been examined, according to Gaith et al. 2018, to provide greater awareness of the program in various health institutions and surrounding academic contexts. It has evolved from a participatory development initiative and specific information about the path's flexibility [14] to a participatory development initiative and a simple idea for flexibility. M. Jacobsen et al. (2018) discovered protective features that contribute to particular system development and characteristics that contribute to effective and efficient academic communication, offering excessive professional support within graduation application. This observation has aided in determining the program's strength for graduate students and how it can appropriately make mistakes [15]. Figure 3 shows the assessment cycle.

Buker and Niklason improved the map version in 2019. They seek to establish fundamental guidelines for curriculum development. Assessing the program's cause and analyzing the findings of compliance-based research are two recommended ways [16]. Treadwell et al. (2019) this study looks at how curriculum mapping is presented in interactive web-based learning opportunities, objectives, and outcomes in consultation with 40 instructors to see how they like it. Although participants did not immediately understand how to use the system and experienced some developmental issues, the results consistently showed that they believed the learning outcomes with university students with many inclusive motivations such as communication, usability, and transparency [17]. The Lacerda and Sepel (2019) study examine educators' views to gather their experiences and generate curricular transformation proposals. Their findings revealed that publishing-interest had become more widely accepted than critical theories and that the outcomes with traditional notions were not sufficiently good. Excellent exercise planning was directly related to good exercise planning [18]. Lindén et al. (2017) discuss the impact of the teaching concept on the development of more excellent knowledge while focusing on its historical and psychological foundations. The findings demonstrate that it adjusts to higher education emergencies. It is necessary to grasp the distinctions between the entire curriculum and the critical points simultaneously and consider the curriculum's influence [19]. There have been significant changes in curriculum thinking over the last decade. The number of troubling issues covered has substantially grown in developing solutions and concepts.

Their findings show that academic research is becoming more comprehensive and prone to educational improvements [20]. They matched their curriculum to those of the United Kingdom and Latvia, simultaneously focusing on historical and theoretical subjects. A physics curriculum was gained by Yates and Millar (2016), notably at universities with Australian inner skills.

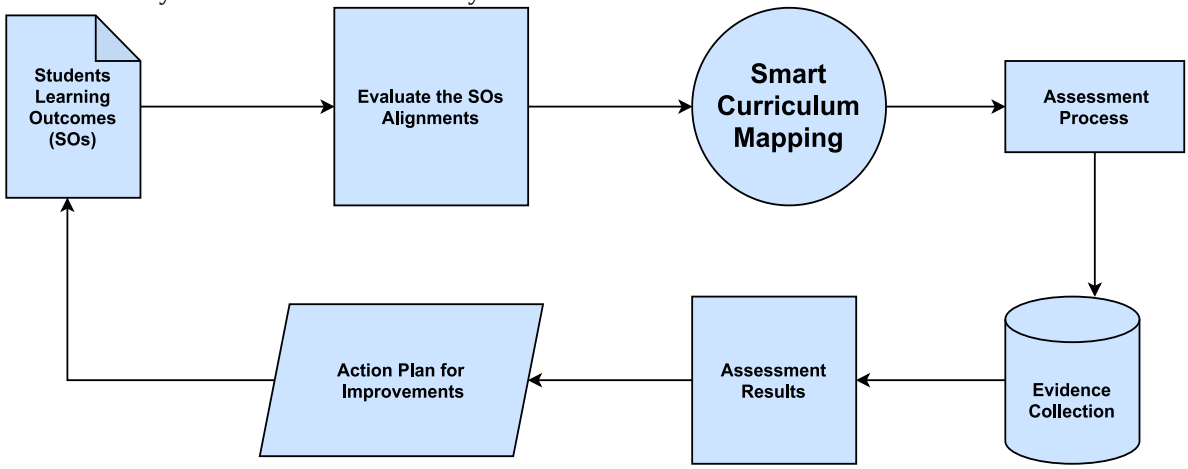


Figure 3: Assessment cycle

Physics has evolved into a unique matter, owing to the vast technical knowledge that must be updated in trading and reviewed over time. Its popularity is based on whether the curriculum can be taken seriously in the workplace [21]. Sweden's new curriculum, which was implemented in 2011, was examined in such a way (Alvunger 2018). According to their findings, the instructor's curriculum establishes three roles inside the class: the interaction area, the arrangement, and the person's view. The answers of academics have provided persuasive evidence that curriculum modifications necessitate a high degree of material content and that lecturers can assess skills without difficulty because they will desire to connect with university college students at the same time [22]. Ghaderia (2011) represents curriculum principles focused on total peace and considers peace necessary for conservation maintenance as technology wars evolve. They believe that combining modern ideas with freedom ideas (that is, by combining similarities and differences) can create a final curriculum that promotes peace [23, 24, 25].

# 3 Methodology

The suggested algorithm analyses the curriculum map based on the students' learning outcomes. In addition to the existing scientific procedures used in curriculum map planning and evaluation, carefully examines every subject-related lesson and curriculum map development to establish the primary method utilized to attain a satisfactory level.

To fulfil the visions, we took a four-step approach:

1. Create curriculum maps and their setups.
2. Guidance on measuring a high-quality course map using an algorithm.
3. Plan a set of suggested guidelines and review them.
4. Research-based expert assessment of outcomes

The following terms I, R and E are employed within the program to connect the curriculum and know the program's outcomes, depending on the model review and the needs for numerous educational accrediting structures (e.g. ABET, NCAAA, etc.).

Introduced (I): students are not expected to become curriculum experts. Students learn to distinguish subjects using basic information, understanding, skills, and talents (first and second year).

Reinforcement(R): students are expected to have a basic understanding and knowledge of the topic or skills. Learning activities help students develop and combine their awareness, skills, and growth challenges (guidelines).

Expert (E): University students are expected to have a strong foundation and understand basic, technical, or fundamental skills. Utilizing information or abilities in various circumstances and varying difficulty levels emphasizes education and knowledge (capstone).

Figure 4 depicts a sample curriculum map. Many of the program findings are no longer matched with themes that are consistent with the superb analysis map's general policies.

The following method must be utilized to generate a wonderful map that provides great satisfaction in knowing the outcomes.

1. Understanding the outcomes: The outcomes should be explained in conjunction with the program and problem headings. The results must be compatible with the program's aims, objectives, and goals.

2. Mapping: Understanding system results should go hand in hand with knowing the consequences. The required subjects should be considered to ensure that students' knowledge is collected and sequenced.

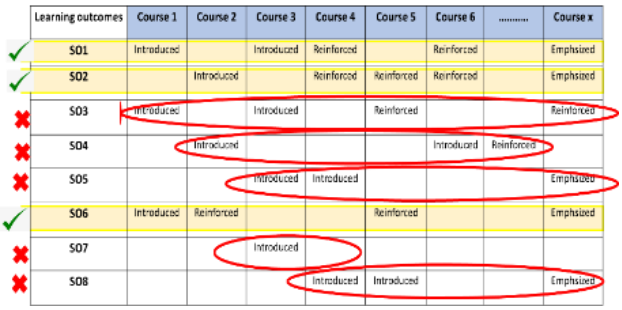


Figure 4: Sample of Curriculum Mapping

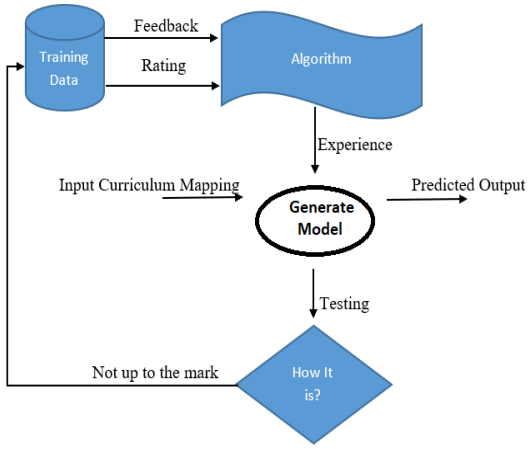


Figure 5: Evaluation of curriculum mapping

Alignment strategies: A set of actions must be used to develop a curriculum map. For instance, a high level of alignment (I, R, E), a list of courses specific to each program, and so on.

Participants should be included in the development of map information acquisition, including professors, and students.

Table 1 displays an example of a curriculum matrix that depicts the relationship between the system's numerous learning outcomes and the curriculum courses.

The following strategies should be employed to earn the first report of any provided curriculum map, based on quality assurance information and permitted enterprises [26, 27, 28].

1. At least three studies must agree with all test outcomes (I, R and E).

2. All lessons should no longer be challenging in all student's outcomes. However, each view must keep at least 3-5 outcomes.

3. The study's findings must be interpreted logically for learners to proceed from the early to the later stages of the period.

4. "I" must be the initial stage, and all of the first lessons must be covered. The "R" should begin at a third of a turn to the stop and cover all crucial and necessary issues. Also, "E" aims to incorporate expertise (capstone).

The ideas listed above can be used to evaluate a curricular map that follows a set of rules. Within the suggested implementation tool, the following sections are used [29, 30, 31, 32].

Phase 1: Discover study and assessment data that match the model and values for analysis procedures. All teachers must be assessed the related information.

Phase 2: Practice learning and data collection to enhance statistical abilities.

Phase 3: Request feedback and a report from the university.

Train the machine with this data, and it will create comments and recommendations with standard rules.

Phase 4: Locate the essential first steps using the curriculum map. Phase four saw an improvement in implementation.

Phase 5: Create a curriculum map model using all factors and clarify it according to the educational outcomes.

After some experience, a set of rules will yield a blueprint for creating a workable curricular map.

Phase 6: Create a curriculum map and determine the expected outcome.

A collection of rules will take your input in the form of a curriculum map and use it to generate output.

Input, processing, and output are suggested in figure 5. The flow of a set of curricular map rules is improved by figure 6.

The above levels will be utilized to assess curriculum map development using digital learning methodologies as described in the recommendations.

The following is a summary of the proposed set of rules:

(1) put in (curriculum map)

(2) Algorithm for mapping curriculum

(3) Output (recommendations)

# 4 Procedure for generating smart curriculum mapping

Curriculum Mapping test method

i) Input- Curriculum map design: says CM

ii) Return information for each column to the CM. According to the data, we define it

$D_{ij} = (C_j L_k \sum_i SO_i)$ where i=1,2,3 ….., j=1,2,3…,

where SO is the outcome of students, L is the grade level, and C is the curriculum's courses.

iii) In step 1, we look for special character sets ($D_{ij}$). For instance: $L_1C_1${I R E R},
$L_2C_2${I I I I E I},
$L_3C_3${I R E R}, and so on.

Each set should be divided into three characters: L, C and {}. Divide each set into three arrays of characters say-Level[i], Courses[j], str[j].

iv) in this step,

a) if i=1 or 2, then go to step 5

b) else if i=3 or 4 or 5, then go to step 6

c) else if i=6 or 7 or 8, then go to step 7

d) else go to Step 8.

v) locate an array of courses[j] and corresponding string str[j]

a) The event that string str[j] has all blank, then Print Error "Course [j] has not aligned with any SO".

b) Differently, if string str[j] has no blank, then Print Error "Course [j] has aligned with all SO".

c) Differently, if str[j] has L and blank mixed characters, then Print "Course [j] has aligned with SOs successfully".

d) Else go to step 4

vi) locate an array of courses[j] and corresponding string str[j]

a) If the str [j] series is empty, then the "course [j] does not match any SO" error message will be displayed.

b) Otherwise, print error "course [j] aligned with all SO" if string str [j] is empty.

c) Print "course [j] aligned with SOs correctly" if str [j] contains M and pure mixed letters.

d) Alternately, proceed to step 4.

vii) Locate a series of course [j] and a SO [j] that corresponds to them.

Print errors "Course [j] is not compatible with any SO" if the string str [j] is empty.

Otherwise, if string str [j] is empty, the error "Course [j] aligned with all SO" will be printed. If str [j] does not contain H or mixed blank characters, print "line [j] aligned with SO nicely."

Alternately, proceed to step 4.

viii) identify all sets of characters from $\sum_i SO_j$

where i = 1, 2, the number of guides and j = 1, 2, number of SOs Keep in mind the vast range of spaces in each set and follow the steps below:

If the total number of empty spaces in any SO set equals the total number of courses, print error "all courses must follow with the rules."

Else Print errors occur when the maximum spacing width is less than 3 or more than 5 lessons for the total number of recommendations. "At least three outcomes must be aligned in all courses (including I, R, and E)."

Print- "Mapping is the best".

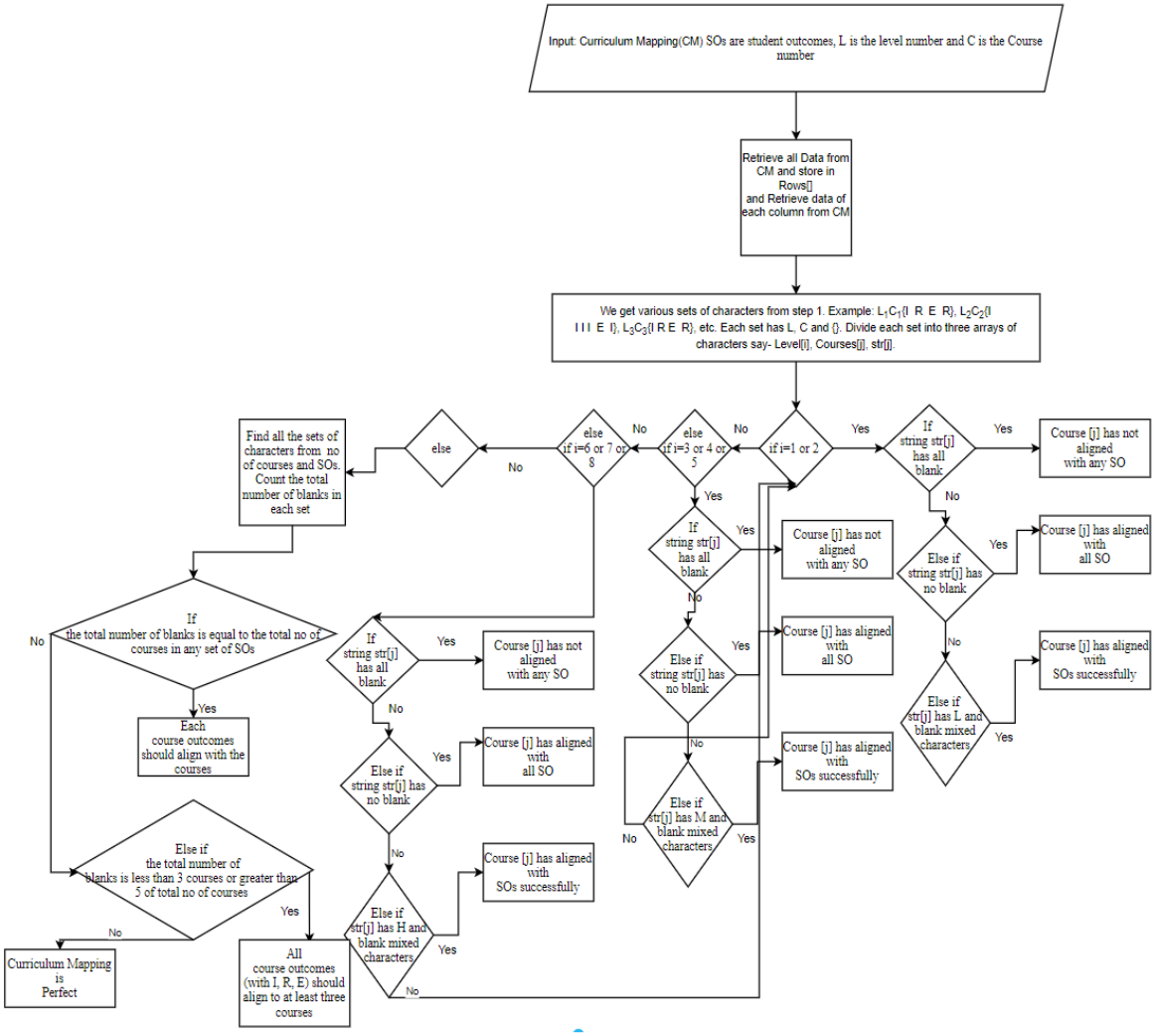


Figure 6: Flow Chart of Curriculum Mapping evaluation

**Recommendations**

1. Course # has not aligned with any SO#.
2. Course # has aligned with all SOs.
3. Course # has not aligned with any SO.
4. Every course outcomes should align with the courses.
5. Every course outcomes should align to at least three courses.
6. Curriculum Mapping is Perfect.
7. Percentage of the perfectness of the curriculum mapping.

Figure 7: Recommendations (Output)

This algorithm generates curriculum map recommendations. Figure 7 shows a list of recommendations. Suggestions can be "Study number does not correspond to any SO", "Course number corresponds to SO successfully", "Study number corresponds to all SO", "The result of each study must correspond to the course.", "At least three subjects must accompany all course outcomes (I, R, E)".

# 5 Results and discussion

Curriculum mapping is usable thru several sources, along with newcomers' students, instructors, universities, and academic groups. Commonly every person in the class is meant to be privy to how the program influences them presently and in the coming years. This research explains the evaluation of curriculum mapping and structures, structures, and guidelines [33, 34, 35]. Developing a conceptual image of an advanced mapping processing method is a tremendous advancement. The mapping is designed for each consultation and needs to be done by every teacher when the bankruptcy content material is changed into created. Further, the researchers additionally protected the views of curriculum mapping specialists, educational professionals, and higher training specialists. There is a diffusion of techniques for collecting statistics, but authors have chosen to apply surveys because those are enormously popular. This collects vital information concerning respondents' observations in each program and assesses their remarks [36, 37, 38, 39]. Forty experts participated in this evaluation, every of whom completed a ten questions survey designed to decide the experts' professions. The following nine questions are regarding curriculum mapping, and they're graded as proven in very satisfied, satisfied, natural, dissatisfied, and eventually very dissatisfied. Curriculum specialists contribute 25% of

people who spoke back to the survey, and educational experts (12.5%) and senior faculty individuals account for the relaxation (37.5%). Absolutely everyone's valued understanding and know-how have enabled them to study how curriculum mapping has been investigated, with more than half mentioning that they're very thrilled or satisfied with what they were provided (12.5% and 12.5%, respectively). The satisfaction level of the question "Do you find the smart curriculum mapping given to you to be useful?" is 70%. The satisfaction level of the question "Would you believe curriculum mapping can aid in the achievement of learning objectives?" is 65%. The satisfaction level of the question "Would you believe smart curriculum mapping can determine curriculum mappings' weak points?" is 88%". The satisfaction level of the question "Would you feel curriculum mapping should be able to make the curriculum more accessible and show the links between the subjects and the learning outcomes of the students?" is 70%. The satisfaction level of the question "Would you accept Smart Curriculum Mapping can assist in suggestions for curriculum design developments?" is 88%. The satisfaction level of the question "Would you believe the Smart Curriculum Mapping would be transparent?" is 85%. The satisfaction level of the question "Would you believe Smart Curriculum Mapping would equally align all student learning outcomes?" is 88%. The satisfaction level of the question "Would you believe the Smart curriculum mapping offered the appropriate balance between theory and practice?" is 85%.

Finally, "the rate of how satisfied you are with the smart curriculum mapping." is 88 %.

The given desk deals with a list of questions in a tabular shape; although you would no longer use a score and instead advocate a consultant place of knowledge, query 1 is isolated from the other questions (Table 2). Table 3 lists each professional's solutions to each question; such solutions are accumulated, and every question's suggestion is determined. Curriculum map visualization has many benefits. A listing of advantages is given below.

1) continuity of concern counts and gaining knowledge of dreams.

2) ongoing, regular, minimum, and repeated development initiatives have all been powerful.

3) aid in furthering one's research (consensus or inclusion).

4) observe and examine the learning effects.

5) enhance the academic body of workers' excellence (capable of percentage the getting to know the process).

6) talk about clarity problems (precise information, plan opinions, academic support, and higher application results).

7) method improvement requirements. Each path might need to broaden a method to evaluate scholar success, thinking of the program's curriculum.

| Questions | 10 Expert | 5 Expert | 15 Expert | 5 Expert | 5 Expert |
|---|---|---|---|---|---|
| Kindly select the option that perfectly represents yourself from the list below. | Educational Specialist | Curriculum Advisor | Professor | Curriculum Professional | Academic Expert |

Table 2. Question 1 presenting the specialists' area of professionalism

| Questions | Expert | Expert | Expert | Expert | Expert | Expert | Expert | Expert | Expert | Expert | otal (max 200) | Percentage(%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Do you find the smart curriculum mapping given to you to be useful? | 16 | 20 | 20 | 20 | 12 | 8 | 8 | 8 | 8 | 12 | 132 | 66 |
| Would you believe curriculum mapping can aid in the achievement of learning objectives? | 16 | 20 | 20 | 20 | 12 | 8 | 8 | 8 | 8 | 16 | 136 | 68 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Would you believe smart curriculum mapping can determine curriculum mappings' weak points? | 16 | 20 | 20 | 20 | 12 | 16 | 16 | 16 | 16 | 16 | 168 | 84 |
| Would you feel curriculum mapping should be able to make the curriculum more accessible and show the links between the subjects and the learning outcomes of the students? | 20 | 20 | 20 | 20 | 12 | 8 | 8 | 8 | 8 | 12 | 136 | 68 |
| Would you accept Smart Curriculum Mapping can assist in suggestions for curriculum design developments? | 16 | 20 | 20 | 20 | 12 | 16 | 16 | 16 | 16 | 16 | 168 | 84 |
| Would you believe the Smart Curriculum Mapping would be transparent? | 16 | 20 | 20 | 20 | 12 | 16 | 16 | 16 | 16 | 12 | 164 | 82 |
| Would you believe Smart Curriculum Mapping would equally align all student learning outcomes? | 16 | 20 | 20 | 20 | 12 | 16 | 16 | 16 | 16 | 16 | 168 | 84 |
| Would you believe the Smart curriculum mapping offered the appropriate balance between theory and practice? | 16 | 16 | 20 | 20 | 12 | 16 | 16 | 16 | 16 | 12 | 160 | 80 |
| Also rate how satisfied you are with the smart curriculum mapping. | 16 | 20 | 20 | 20 | 12 | 16 | 16 | 16 | 16 | 16 | 168 | 84 |

Table 3. Questionnaire results (Q2-10) with averages

| | Introduced | Reinforced | Emphasized |
|---|---|---|---|
| Corrective Expertise | 4 | 5 | 3 |
| Essential Imagining | 7 | 2 | 1 |
| Interaction | 2 | 3 | 9 |
| Study Abilities | 3 | 2 | 2 |
| Moral Analysis | 3 | 1 | 1 |

Table 4. Statistics of learning outcomes vs strength of curricula

The comprehensive evaluation software includes getting to know results, the manner used to evaluate each outcome, every strategic mark, the individual responsible for collecting records, the accrued information, the responsibility for decoding outcomes and acquiring corrections, and evaluating enhancements (figure 6, table 4).

We expect that the getting to know outcomes of the 14 students are divided into discipline understanding, vital questioning, verbal exchange, research abilities, and a behavioural session on the desired topics. In keeping with the effects of this take a look at, most professionals are satisfied with the proposed approach. Desk 3 shows the outcomes of the expert evaluations. Curriculum evaluations can be trendy, but the wide variety of variables, including entering records and available assets, relies upon whether the entire curriculum is classed. Establishments should be privy to the need for high stage checking out and strategies for undertaking all assessments. On every occasion, the consequences of the instructions are explained, they allow the mapping of their classes.


Figure 7: Student's learning outcomes for mandatory courses

## 6 Conclusion

In the meantime, several universities employ curriculum map modification tools to analyze and improve curriculum consistency and give great development accuracy in higher education. They developed and integrated a good (developmental, organized, and meaningful) learning environment. Once SO has agreed to the design, ensure that activities are grouped so that the most common learning technique can learn. Building a curriculum map helps demonstrate the relationship between instruction and student outcomes understanding and provides a more thorough curriculum overview. This study has produced, examined, and algorithmically suggested an outstanding curricular map. The syllabus set of curriculum maps analyses the curriculum and provides recommendations for the map's correctness based on all of the principles used to assess the syllabus's suitable quality. In conclusion, this algorithm could be developed in higher education institutions to boost the acquisition of specialized knowledge even more.

## References

[1] Bone, E. K., & Ross, P. M. (2021). Rational curriculum processes: revising learning outcomes is essential yet insufficient for a twenty-first century science curriculum. Studies in Higher Education, 46(2), 394-405. https://doi.org/10.1080/03075079.2019.1637845

[2] Lafave, L. M., Yeo, M., & Lafave, M. R. (2021). Concept mapping toward competency: Teaching and assessing undergraduate evidence-informed practice. The Journal of Competency-Based Education, e1242. https://doi.org/10.1002/cbe2.1242

[3] Webb, K. K. (2020). Curriculum mapping in academic libraries revisited: Taking an evidence-based approach. College & Research Libraries News, 81(1), 30. https://doi.org/10.5860/crln.81.1.30

[4] Joyner, H. S. (2016). Curriculum mapping: A method to assess and refine undergraduate degree programs. Journal of Food Science Education, 15(3), 83-100. https://doi.org/10.1111/1541-4329.12086

[5] Herrmann, T., & Leggett, T. (2019). Curriculum Mapping: Aligning Content and Design. Radiologic technology, 90(5), 530-533.

[6] Plaza, C. M., Draugalis, J. R., Slack, M. K., Skrepnek, G. H., & Sauer, K. A. (2007). Curriculum mapping in program assessment and evaluation. American Journal of Pharmaceutical Education, 71(2). https://doi.org/10.5688/aj710220

[7] Uchiyama, K. P., & Radin, J. L. (2009). Curriculum mapping in higher education: A vehicle for collaboration. Innovative Higher Education, 33(4), 271-280. https://doi.org/10.1007/s10755-008-9078-8

[8] Perlin, M. S. (2011). Curriculum mapping for program evaluation and CAHME accreditation. Journal of Health Administration Education, 28(1), 33-53.

[9] Spencer, D., Riddle, M., & Knewstubb, B. (2012). Curriculum mapping to embed graduate capabilities. Higher Education Research & Development, 31(2), 217-231. https://doi.org/10.1080/07294360.2011.554387

[10] Lam, B. H., & Tsui, K. T. (2013). Examining the alignment of subject learning outcomes and course curricula through curriculum mapping. Australian Journal of Teacher Education, 38(12), 6. https://doi.org/10.14221/ajte.2013v38n12.8

[11] Avella, J. T., Kebritchi, M., Nunn, S. G., & Kanai, T. (2016). Learning analytics methods, benefits, and challenges in higher education: A systematic literature review. Online Learning, 20(2), 13-29. https://doi.org/10.24059/olj.v20i2.790

[12] Hutchings, Pat. (2016). "Aligning educational outcomes and practices." https://files.eric.ed.gov/fulltext/ED567005.pdf

[13] Jacobsen, M., Eaton, S. E., Brown, B., Simmons, M., & McDermott, M. (2018). Action research for graduate program improvements: A response to curriculum mapping and review. Canadian Journal of Higher Education/Revue canadienne d'enseignement supérieur, 48(1), 82-98. https://doi.org/10.47678/cjhe.v48i1.188048

[14] Al-Eyd, G., Achike, F., Agarwal, M., Atamna, H., Atapattu, D. N., Castro, L., ... & Nausheen, F. (2018). Curriculum mapping as a tool to facilitate curriculum development: a new School of Medicine experience. BMC medical education, 18(1), 1-8. https://doi.org/10.1186/s12909-018-1289-9

[15] Jacobsen, M., McDermott, M., Brown, B., Eaton, S. E., & Simmons, M. (2018). Graduate students' research-based learning experiences in an online Master of Education program. https://doi.org/10.53761/1.15.4.4

[16] Buker, M., & Niklason, G. (2019). Curriculum Evaluation & Improvement Model. The Journal of Health Administration Education, 36(1), 37.

[17] Treadwell, I., Ahlers, O., & Botha, G. C. (2019). Initiating curriculum mapping on the web-based, interactive learning opportunities, objectives and outcome platform (LOOOP). African Journal of Health Professions Education, 11(1), 27-31. https://doi.org/10.7196/AJHPE.2019.v11i1.1073

[18] Lacerda, C. C., & Sepel, L. M. N. (2019). Basic school teachers' perceptions about curriculum theories. Educação e Pesquisa, 45. https://doi.org/10.1590/s1678-4634201945197016

[19] Lindén, J., Annala, J., & Coate, K. (2017). The role of curriculum theory in contemporary higher education research and practice. In Theory and method in higher education research. Emerald Publishing Limited. https://doi.org/10.1108/S2056-375220170000003008

[20] Rouk, V. (2013). From Times of Transition to Adaptation: Background and Theoretical Approach to the Curriculum Reform in Estonia 1987-1996. Bulgarian Comparative Education Society.

[21] Yates, L., & Millar, V. (2016). 'Powerful knowledge'curriculum theories and the case of physics. The Curriculum Journal, 27(3), 298-312. https://doi.org/10.1080/09585176.2016.1174141

[22] Alvunger, D. (2018). Teachers' curriculum agency in teaching a standards-based curriculum. The Curriculum Journal, 29(4), 479-498. https://doi.org/10.1080/09585176.2018.1486721

[23] Ghaderia, M. (2011). Peace-based curriculum based on the theories of "difference" and "similarity". Procedia-Social and Behavioral Sciences, 15, 3430-3440. https://doi.org/10.1016/j.sbspro.2011.04.314

[24] https://cte.tamu.edu/getattachment/Faculty-Teaching-Resource/Program-ReDesign/Curriculum-Mapping/Curriculum-Process-Overview-and-Instructions-SS-DF-(1).pdf.aspx?lang=en-US accessed on: 21-12-2021

[25] Assessment and Curriculum Support Center, University of Hawai‘i at Mānoa (2020). http://manoa.hawaii.edu/assessment/howto/mapping.htm accessed on: 21-12-2021

[26] Curriculum Design, University of South Florida. (2020). https://www.usf.edu/atle/teaching/curriculum-design.aspx accessed on: 21-12-2021

[27] Codó, E., Dans, L., & Wei, M. M. (2008). Interviews and questionnaires. The Blackwell guide to research methods in bilingualism and multilingualism, 158-176. https://doi.org/10.1002/9781444301120.ch9

[28] Patten, M. L. (2016). Questionnaire research: A practical guide. Routledge. https://doi.org/10.4324/9781315265858

[29] Champlain College, Curriculum mapping. (2020). Assessing Learning Outcomes. https://champlain.instructure.com/courses/200147/pages/curriculum-mapping accessed on: 21-12-2021

[30] Abdullah Alshanqiti, Tanweer Alam, Mohamed Benaida, Abdallah Namoun and Ahmad Taleb, (2020) "A Rule-based Approach toward Automating the Assessments of Academic Curriculum Mapping" International Journal of Advanced Computer Science and Applications (IJACSA), 11(12). http://dx.doi.org/10.14569/IJACSA.2020.0111285

[31] Melody, K., Quinn, D.H., Waite, L.H., Mandos, L.A. and Tietze, K.J., 2021. Curriculum mapping: A process to revise the path to achieving student competency. *Education in the Health Professions*, *4*(1), p.1. https://doi.org/10.4103/ehp.ehp_41_20

[32] Cooper, B., Cowie, B., & Furness, J. (2021). Curriculum mapping as a boundary encounter: meeting the demands of multiple agendas. Educational Research for Policy and Practice, 1-22. https://doi.org/10.1007/s10671-021-09299-5

[33] Willans, F. (2021). Mapping the curriculum or doing curriculum mapping? A view from Linguistics and Language programmes. Directions: Journal of Educational Studies, 35(1), 29-37. http://repository.usp.ac.fj/id/eprint/12931

[34] Harden, R. M. (2001). Curriculum mapping: a tool for transparent and authentic teaching and learning. AMEE. https://doi.org/10.1080/01421590120036547

[35] Aljohani, M., & Alam, T. (2015, December). Design an M-learning framework for smart learning in ad hoc network of Android devices. In 2015 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC) (pp. 1-5). IEEE. https://doi.org/10.1109/ICCIC.2015.7435817

[36] Alam, T., & Aljohani, M. (2020). M-Learning: Positioning the Academics to the Smart devices in the Connected Future. JOIV: International Journal on Informatics Visualization, 4(2), 76-79. http://dx.doi.org/10.30630/joiv.4.2.347

[37] Alepis, E., & Troussas, C. (2017). M-learning programming platform: Evaluation in elementary schools. Informatica, 41(4). https://www.informatica.si/index.php/informatica/article/view/1496

[38] Vičič, J., & Šukljan, T. (2016). Motivating cultural heritage artifacts presentation using persuasive technology. Informatica, 40(4). https://www.informatica.si/index.php/informatica/article/view/1466

[39] Zhu, F. (2018). Research on Intelligent English Oral Training System in Mobile Network. Informatica, 42(2). https://www.informatica.si/index.php/informatica/article/view/2216