Scenario-based learning pedagogical guidelines

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Contents

1. GLOSSARY

- SBL – Scenario-Based Learning
- student - a person who attends a school, college, or university
- lecture – a formal talk on a serious subject given to a group of people, especially students learning methodology
- stage – possible events in which students are independently looking for possible solutions
- pathway – sequence of stages appearing in the implemented scenario (a sequence of steps showing a way to solve the problem)
- scenario – one of the narrative thread forming a complex story
- storyline – set of scenarios for given subject
- Lecture Knowledge Base (LKB) – the set including all possible forms of data within the scope of the topic
- SFLM – Super Fast Learning Machine

2. INTRODUCTION

Scenario-Based Learning (SBL) [3] uses interactive scenarios involving learners working their way through a storyline. The purpose of this methodology is to learn how to solve a given problem (defined by a question for whom a solution is sought), e.g. how to build a webshop application?

The purpose of the Pedagogical Guideline (PG) is to enter the user to the area of the scenario-based learning methodology, in particular concern questions:

- how to develop a lecture using SBL approach (by adopting asynchronous mode), i.e. What structure of the scenario should be adopted? How to build a storyline? And how to use the SFLM in the process of preparing a lecture?
- how to conduct lectures (by adopting synchronous mode) using the developed storyline, i.e. How to moderate discussion among students? - How to assess learning outcomes? etc.

According to the above, the PG is divided into two parts (according to simplicity rules [1, 2]): Course Scripting (presenting the traditional and extended by the SFLM approach) and Course Flow, supplemented by Good Practices and Tips. The PG is based on the *Introduction to the Scenario-based learning methodology*, which contains all necessary information about SBL. Assumed structure of PG is presented on the Fig. 1. The PG is addressed to Academic teachers that have limited knowledge on scenario-based learning methodology but they have experience in the area of e-learning.

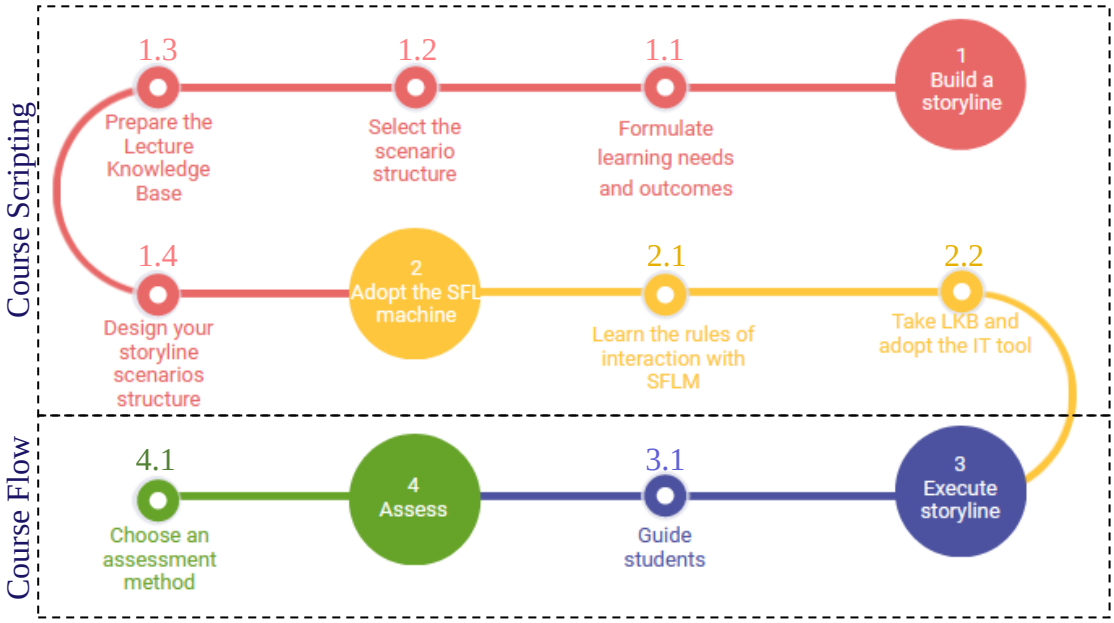


Fig. 1 Structure of PG

3. COURSE SCRIPTING

3.1. Build a storyline

3.1.1. Formulate learning needs and outcomes

Preparation of the correct scenario first of all requires to define learning outcomes which students have to achieve during its implementation. The teacher should therefore answer the following questions:

What do you expect your learners to experience after they complete the course?

What are the situations where the learners will be expected to apply their knowledge?

It is worth noting that learning outcomes should refer to the issue presented during the classes, and be defined in such a way that their easy verification is possible (i.e. should be measurable). Scenario-Based Learning methodology is recommended primarily for the following areas:

Practical courses:

Scenario-Based Learning methodology is a good way to learn practical (factual) tasks, SBL helps learners to learn the steps or procedure to complete the task. It is recommended that there are only a few correct pathways of proceeding and relatively few alternative ones. SBL can also be used to learn theory, but this requires the development of a proper storyline, e.g. in the case of presentation of the story written in the book, the scenario could be seen as a sequence of hero. An appropriate example of learning outcomes and the method of their verification can be stated as follows:

Learning outcomes: getting to know and standardizing the resolution procedures solving a task of a given type

Verification of learning outcomes: execution of the task in accordance with the procedure and comparison of results to the reference standard.

Situated learning:

Scenarios are ideal for aspects of the curriculum that lend themselves to situated learning where contextual knowledge is highly prized. The way learners navigate through the scenario process with its accompanying questions, problems and dilemmas will determine what and how they learn. An appropriate example of learning outcomes and the method of their verification can be stated as follows:

Learning outcomes: the ability to analyze to evaluate and choose the right pathway solution.

Verification of learning outcomes: measurement of the obtained result and comparison to the classification key.

Case studies:

SBL can allow teacher and learners to explore quasi-professional situations. This is achieved by using realistic circumstances, authentic tasks and communicational styles similar to those found in the profession. In this respect, the learning outcomes achieved allows to shape skills resulting in critical self-assessment of learner-proposed solutions. These skills are acquired through the experience gathered during a given scenario implementation. An appropriate example of learning outcomes and the method of their verification can be stated as follows:

Learning outcomes: allows to shape skills resulting in critical self-assessment of learner-proposed solutions.

Verification of learning outcomes: indication of the disadvantages of one's one approach and advantages of other students' approach.

EXAMPLE

A real-life example of *learning outcomes* is illustrated in the following (practical course) scenario:

Let's consider a case in which the teacher plans to implement the content of education related to the topic of the database entity modelling. Consequently, the teacher should choose the leading example of the discussed problem field (e.g. database for the online store, the hotel, the library, etc.) and then one of the ways to build databases (e.g. top-down, bottom-up). In this situation, he/she assumes that in the first stage of the scenario should present the issue of his choice (i.e. characteristics of the selected object, e.g. online store) and allow students to discuss potential functionalities of the designed database). In the next steps, the teacher should also initiate discussions and ask students for their ideas as well as comments and remarks (e.g. the teacher asks what data characterizes the customer of the online store). It is important that discussions ran in a good atmosphere and each of the students could speak while the ideas expressed may be repeated. The recommended number of participants is from 3 to 10 students.

It is assumed that after completing the scenario, students should obtain the following learning outcomes:

1. The student knows and understands basic terms related to the principles of modeling and database design.
2. The student knows the methodology of database design.
3. The student can design database structure.
4. The student can design correct relational diagrams.
5. The student can use typical software tools in programming practice.
6. The student can independently analyze the designed database.
7. The student is aware of the responsibility of the database designer.
8. The student is able to identify common database errors.

Verification of learning outcomes: practical exam, the student receives information about another business field and by analogy with the above example builds a new database.

3.1.2. Select the scenario structure

The next stage is to prepare the scenario, which involves the need to determine its structure. At this stage, the teacher is looking for an answer to the following question:

What structure of the scenario should be adopted for the lecture in question?

In general case SBL can be implemented in one of the following versions:

- Skill-Based Scenario: In this scenario, the learner is expected to demonstrate skills and knowledge he/she has already acquired.

  Example – the music lesson: playing instruments in a music band. Each student already knows how to play their instrument, now they are learning playing together with sheet music under the supervision of a conductor.

- Problem-Based Scenario: This type of scenario is ideal for situations where learners must integrate their theoretical and practical knowledge to investigate a problem.

  Example –the geography lesson: teaching about urbanization and urban design. Each student has knowledge of the chosen field (e.g. resulting from their own interests or professional work); one of students knows and understands the need to maintain order, another student knows the principles of municipal management, and yet another student knows the culture, students must design the city together that will last for many years.

- Issue-Based Scenario: In this type of a scenario, learners get to take a stand on issues (usually with humanitarian perspectives), to understand how different solutions affect decision-making in professional spheres.

Example – the economics lesson: students learn how to manage a joint business. everyone takes on one of the roles (e.g. a manager, an accountant, a salesperson), at the same time, one of them receives the secret task of resignation from work or failure to perform the entrusted task. Other students must adapt to the new situation and anticipate different scenarios of what they can do (e.g. divide among themselves new responsibilities to hire a new employee who will require time for implementation).

- Speculative Scenario: In this scenario, learners must predict the outcome of an event in the future based on their knowledge and deductions.

  Example - lesson in hotel school: students get a sample description of a specific accommodation facility (e.g. a holiday resort consisting of many buildings scattered over a large space), have at their disposal a computer program for hotel service known to them, discuss whether they will be able to handle all processes using this program or which of the proposed versions of support will be better.

- Gaming Scenario: As results from the terminology introduced, these scenarios involve the use of games as learning tools.

  Example – the history lesson: students use a map board, figurines of soldiers to be reproduced to map the course of the battle or other historical events, the teacher leads a narrative which guides students to activities consistent with history.

A common feature of these approaches is the adopted reference scheme of storyline scenarios presented in next section.

EXAMPLE
Continuing the example from the previous section, let's consider the situation in which the teacher has decided that the scenario will be implemented in the speculative scenario structure. He/She justified his/her decision as follows: Students building a database will make a choice at selected stages of the script.

Making a choice requires a discussion about the advantages and disadvantages of a given solution. Often, however some discrepancies in students' opinion may appear that force the need for forecasts and impact assessments of a given (undertaken) choices. Following above classification the adoption of such a process of conducting classes corresponds to the speculative scenario structure.

3.1.3. Prepare the Lecture Knowledge Base

The storyline scenarios structure design should be preceded by the collection of the data (knowledge) in the scope of the subject. This means that the teacher should find the answer to the following question:

How look like the Lecture Knowledge Base for considered subject?

The Lecture Knowledge Base (**LKB**) here should be understood as the set including all possible forms of data within the scope of the topic under consideration such as

books, scientific publications, guides, application documentation, multimedia presentations, blogs, discussion forums, social profiles, videos and so on. It should be emphasized that the richer the data set the greater the potential for lecture design and on the other hand, the more difficult process of viewing them and extracting the right content.

EXAMPLE
Preparing a lecture teacher on the basis of his knowledge and experience selects basic topics referring to databases which then explains based on available sources.

Topic - 1: basic elements of databases:

- relational database - *proposed by Edgar Codd (of IBM Research) around 1969. It has since become the dominant database model for commercial applications….* Relational Database Design (ntu.edu.sg)
- primary key / foreign key - *In the relational model, a table cannot contain duplicate rows, because that would create ambiguities in retrieval. To ensure uniqueness, each table should have a column (or a set of columns), called primary key….* Relational Database Design (ntu.edu.sg)
- Entity - The types of information that are saved in the database are called 'entities'…. Introduction to Database Design | Tutorial | Datanamic
- Relationship - *relationships between the entities and to determine the cardinality of each relationship. The relationship is the connection between the entities…* Introduction to Database Design | Tutorial | Datanamic

Topic- 2: webshop database:

- *Imagine that you are creating a website for a shop, what kind of information do you have to deal with? In a shop you sell your products to customers. The "Shop" is a location; "Sale" is an event; "Products" are things; and "Customers" are people. These are all entities that need to be included in your database.* Introduction to Database Design | Tutorial | Datanamic

Topic- 3: … **etc.**

In this context, LKB should be understood as a collection of source materials supporting learning in the field of defined topics.

3.1.4. Design your storyline scenarios structure

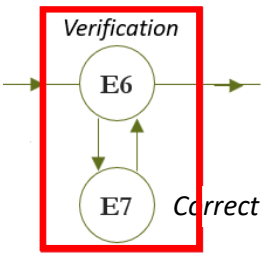
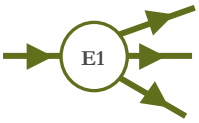
A key stage in the process of developing a lecture following SBL approach is to prepare a storyline scenario structure of a selected lecture topic (subject). At this stage, the teacher is looking for an answer to the following question:

How design a storyline for considered subject?

SBL's storyline models realistic situation in which the sequence of stages and accompanying choices allow the learner to achieve the expected result. Learning occurs when the learner goes through the storyline and is guided to discover principles and develop

critical competencies. The simplest way to design a scenario is to use a pattern case following arbitrarily chosen practical task. One of most commonly used approach to storyline design is based on graphic representation in which the threads of the scenario form a graph of transitions. The basic components of such representation are presented in the table 1.

Table. 1 Elements of the graph representing the Storyline

Icon and name	**Description**
Stage: 	Stages representing possible events, where students are independently looking for possible solutions.
Continuous edge: 	Edges linking subsequent stages.
Edge in bold: 	Recommended direction of passage
Dashed edge (backtracking): 	In the event of incorrect implementation of the scenario the student should know which stage to return to: 1. Correct the mistakes made 2. Continue on the right pathway 3. Learn how to fix specific errors For this purpose, dashed edges are used.
Loop: 	Edges of this type are used to emphasize repeatability (periodicity and/or iterativeness) two sentences, e.g. Verification of the correctness of the stage and then making changes.
Path/Pathway: 	Pathways are composed of stages appearing in the implemented scenario. Some of them may lead to wrong decisions.
Fork: 	The stage in which one of the available pathways should be chosen. The choice can be thought out (resulting from the discussion) or unconscious or just obvious (students have the necessary knowledge).

The most important element of storyline is the stage. The stage represents possible events (sub-problems), where students are independently looking for possible solutions, e.g. as a result of discussions. Defining a stage the teacher should formulate the following elements:

- Topics – the set of keywords related with the stage subject,
- Questions/Goals – the set of questions/goals for which students should find the answers/solutions,

- Materials – the set of sources related with the stage subject,
- Learning outcomes – the set of learning outcomes related with the stage subject.

An example graph representing the storyline is shown on Fig. 2. A presented storyline consist of 11 stages, which create 3 pathways:

- Pathway 1 covering stages: E1, E2, E3, E4, E5,E6,
- Pathway 2 covering stages: E1, E2, E7, E8,
- Pathway 3 covering stages: E1, E2, E3, E9, E10, E11.

Two of them (i.e. the pathway 2 and 3) lead to incorrect results, which in practice means that their choice will result in a return to the pathway 1. In case of the pathway 2 the return to the stage E2 and in the case of pathway 3 to the stage E3. Including in the storyline the possibility of choosing decisions resulting in wrong pathways allows students to be made aware about mistakes that they can make within the framework of solved issues. Skillful creation of the storyline in such a way that it contains both correct (usually one recommended) and incorrect (most often no more than three) is the biggest challenge in the SBL approach. traditional approach to the storyline synthesis assumes that the lecturer has access to the Lecture Knowledge Base which it extracts the subsequent stages of pathways that make up the storyline.

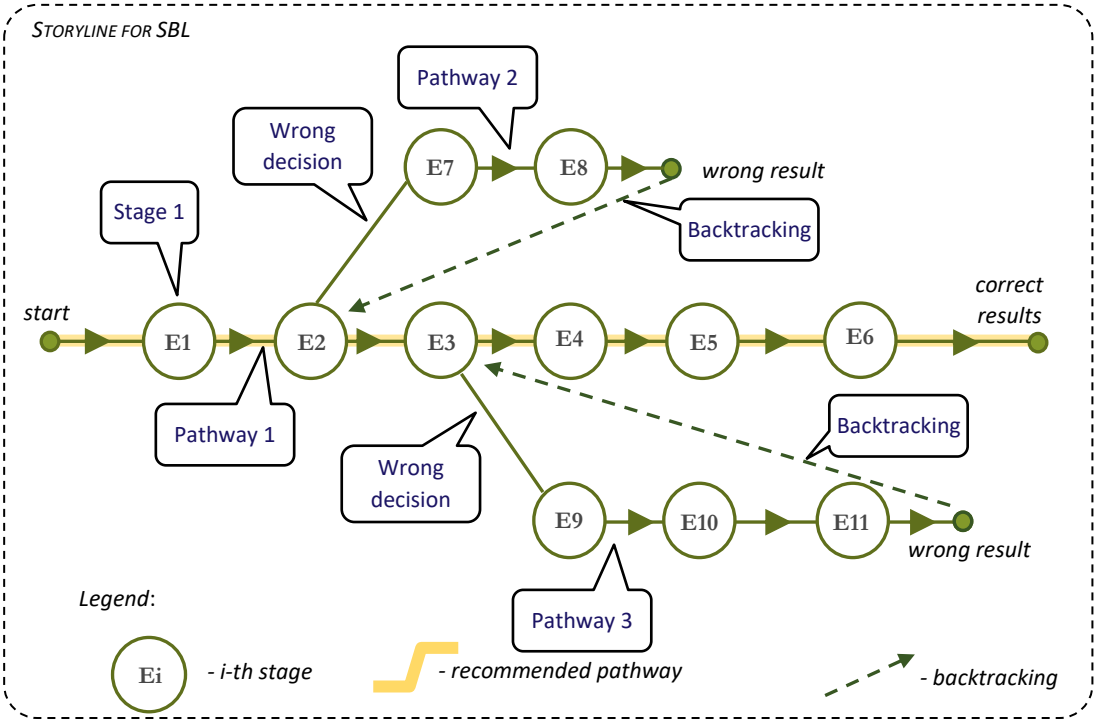


Fig. 2 A storyline seen as a sequence of steps showing a way to solve the problem

Step-by-step teacher develops existing pathways until it recognizes that the content contained in it will make it possible to achieve the expected learning outcomes. The detailed procedure is illustrated on Fig. 3.

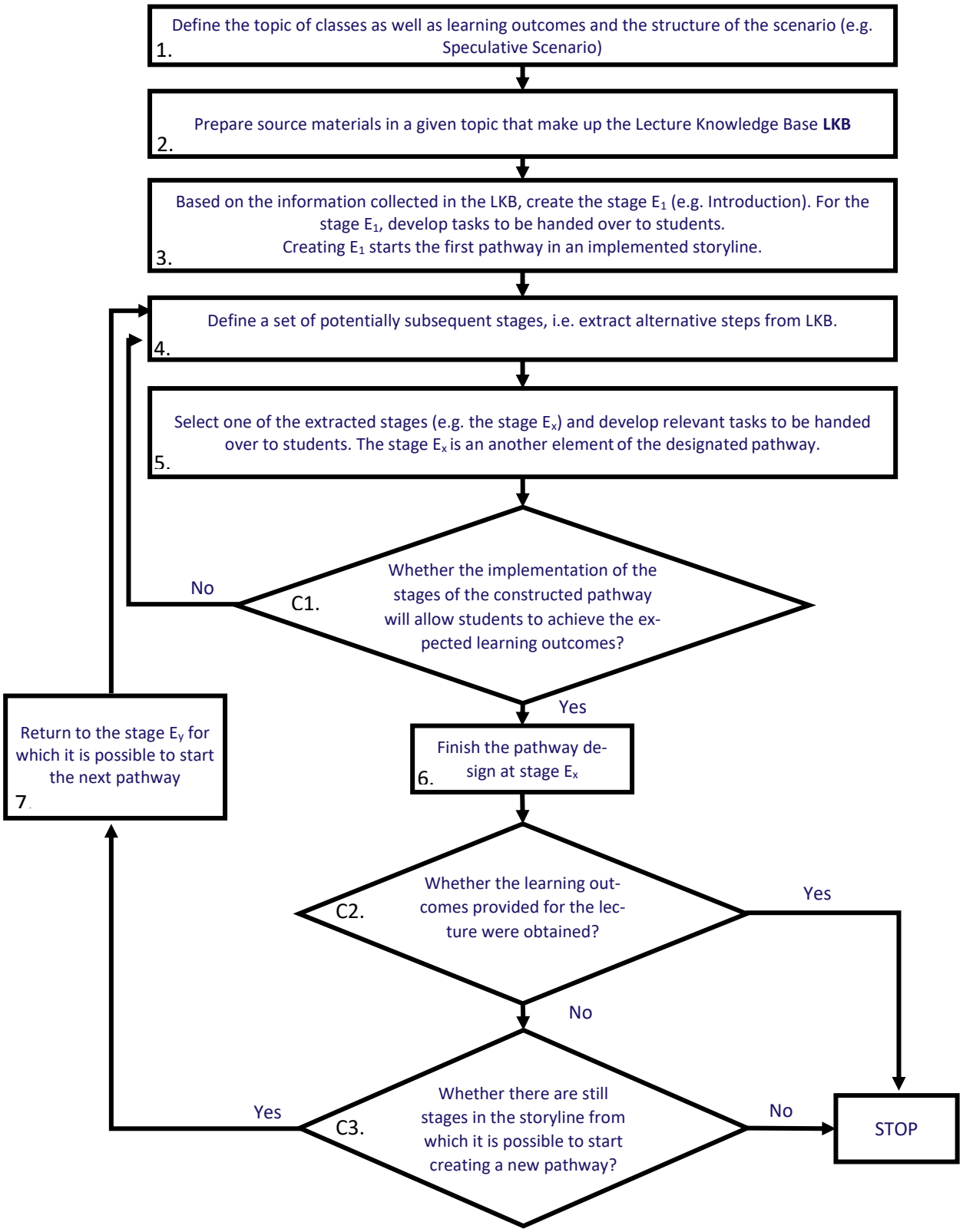


Fig. 3 Procedure of storyline design

According to it, the storyline designing process is completed when the teacher is unable to extract from LKB more pathways or when the existing pathways will make it possible to reach the expected learning outcomes. Verification of the above conditions

requires the teacher to have the ability to effectively search information search of information in the available LKB. The number of available sources of information available today (that make up LKB) is so large that searching them is beyond the teacher's capabilities. Therefore this process needs support. The next section will show how to use the SFLM to design a storyline for SBL.

EXAMPLE

Let's illustrate the possibilities of using the procedure from Fig. 3 to design a lecture scenario in the field of databases.

Procedure – step 1. The teacher defines the class topic: designing the database of the online store and selects speculative scenario. Also defines the expected learning outcomes - as shown in the sections 2.1.1; 2.1.2

Procedure – step 2. As shown in the section 2.1.3, the teacher prepares LKB.

Procedure – step 3. The teacher chooses the right topic to start the scenario - in the case considered, the teacher prepares a narrative about the online store (resembles the basic functions of such a store) and then designs E1 – Introduction, see Fig. 4a.

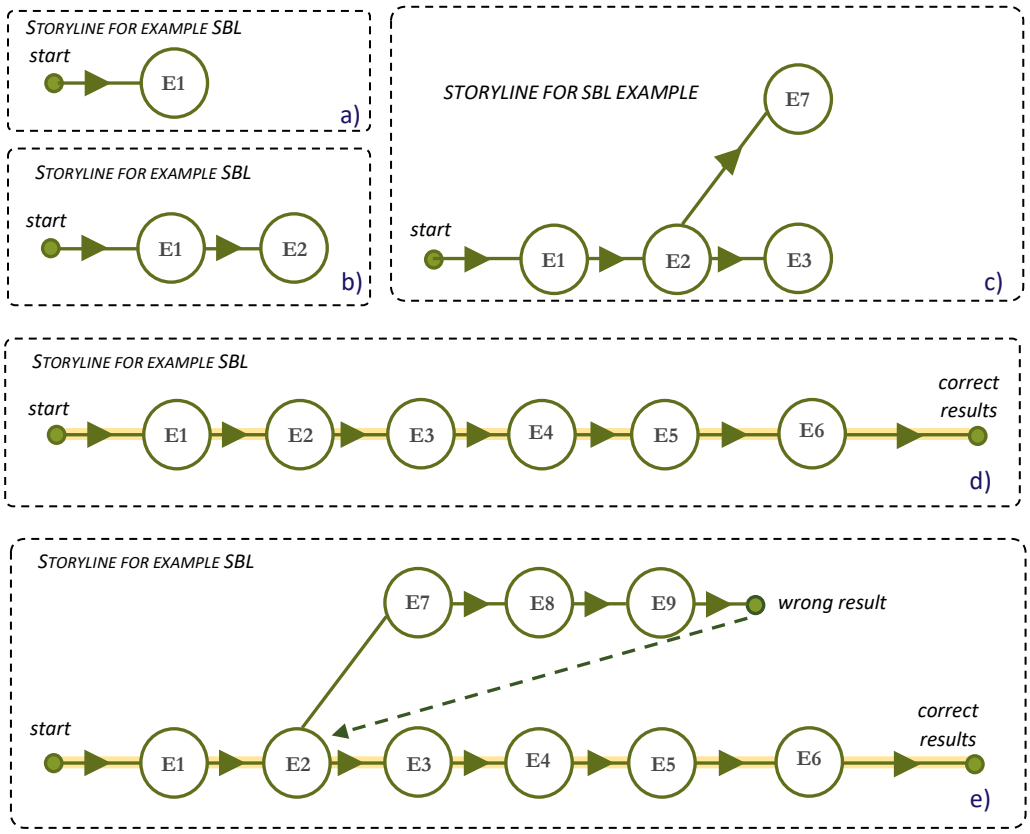


Fig. 4 The steps used in above example illustrating scenario design.

Procedure – step 4. On the basis of the information available in LKB the teacher defines the next stage starting from the stage E1, i.e. stages: E2 –Entities , see Fig. 4b.

Procedure – step 5. The teacher chooses E2 and prepares a narrative introducing entities: Product, Customer, Order.

Procedure - condition C1. Stages E1 and E2 do not yet allow to obtain expected learning outcomes, so the teacher backs to step 4 and defines the next potentially stages starting from the stage E2, i.e. stage E3 – Association Entities and stage E7 - Wrong Entities, see Fig. 4c.

Then according to step 5, the teacher chooses E3 and prepares a narrative introducing entities: Order_Details, Delivery. Steps 4 and 5 are duplicated by the teacher, until he/she achieves expected pathway – see Fig. 4d. In the same way, the teacher implements subsequent pathways until the moment when all learning outcomes for the lecture are obtained (Condition C2) or when alternative pathways cannot be designed (Condition C3). In the case under consideration, the procedure has been completed after building two pathways containing a total of 9 stages – Fig. 4e. Noteworthy is the fact that the pathway consisting of E1, E2, E7, E8, E9 stages leads to a wrong solution (the obtained database prevents the introduction of simultaneous orders of several pieces of the product) I i.e. a mistake commonly committed by beginner database designers. The implementation of this pathway makes it possible to teach students both identification of this type of errors as well as the method of avoiding them (back way to E2).

3.2. Adopt the SFL machine

3.2.1. Learn the rules of interaction with SFLM

The procedure from the Fig. 3 shows the traditional approach of SBL's storyline designing. As noted in the previous point, the SBL requires the ability to extract information from huge LKB (covering: e-books, publications, guidelines, etc.). This process is the most difficult stage of the presented procedure.

Super Fast Learning Machine (**SFLM)** is a tool that can support the user in the scope of searching available sources of information, see Fig. 5. In particular, the SFLM supports the user in the subsequent, i.e. 2, 3 and 4 stages of the proposed procedure. In particularly SFLM extracts the elements required to design each stage of storyline, i.e.: the questions, answers and sources from which they are produced.

3.2.2. Take LKB and adopt the IT tool

For more information about IT Tool, see E-Stem SFL Machine Technical Guidelines.

EXAMPLE
Consider the example of designing a storyline for the lecture from the previous point. This time the teacher is supported (in stages 2, 3, 4) by the SFLM.

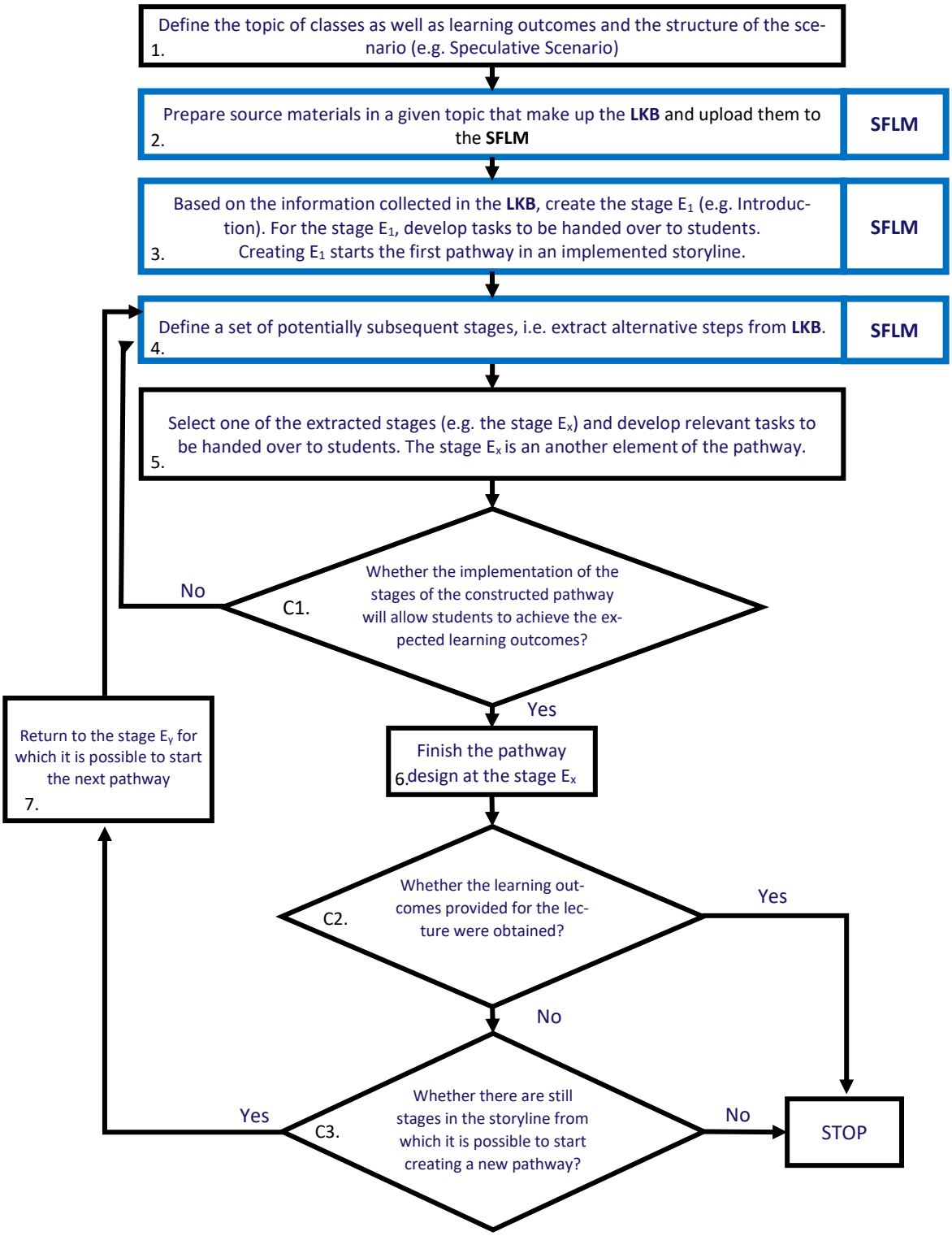


Fig. 5 Procedure of storyline design supported by the SFLM

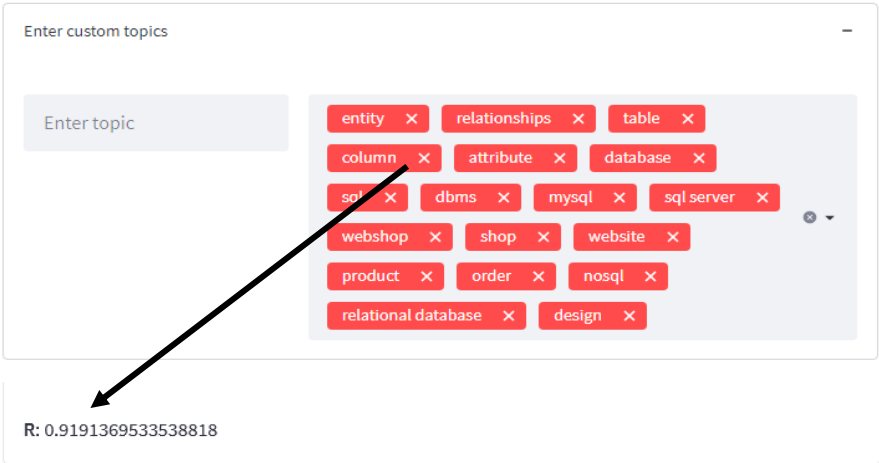


Fig. 6 Relevance assessment value of topics declared in the user's list.

Tab.1. Set of extracted sources following the topics form Fig. 6.

Topics	***Sources from SFLM***
dbms	**Q**: Whom database management systems are developed by? **A**: By several software companies **S**: Today, relational database management systems are the most used DBMS's and are developed by several software companies. **R**: 0.7264801859855652
relational database	**Q**: In which conditions MongoDB may seem? **A**: If you 've worked with classic relational databases **S**: If you've worked with classic relational databases, MongoDB may seem a bit strange. **R**: 0.6323799811876737
relational database	**Q**: In which conditions for example the stock information which is stored in relational tables can be transformed into xml format? **A**: If a web service is invoked that returns the stock quote for the given stock code (as an xml document) **S**: For example, if a web service is invoked that returns the stock quote for the given stock code (as an XML document) then the stock information which is stored in relational tables can be transformed into XML format and then the web service can send the same XML to the requesting application. **R**: 0.5812250481282647
sql	**Q**: How SQL is accepted? **A**: As the standard language for relational databases **S**: SQL today is accepted as the standard language for relational databases. **R**: 0.5684181383022895
webshop	**Q**: In which conditions in a " product sales " database a customer may place many orders? **A**: while an order is placed by one particular customer **S**: In a "product sales" database, a customer may place many orders; while an order is placed by one particular customer. **R**: 0.6360608791359342

During the procedure from Fig. 5, in step 2, the teacher uploads the (prepared before) materials to the SFLM (see the SFLM Technical Guidelines and E-Stem SFL Machine Technical Guidelines rev 3.1 pp. 4-5). Materials processes by the SFLM are then ranked by relevance score (R) according to compatibility with the set of topics selected in advance by the teacher (see and E-Stem SFL Machine Technical Guidelines rev 3.1, pp. 13-15). In turn, topics (see Fig. 6) help the to find the right sources for the required lecture content. The SFLM system returns information about which parts of submitted materials contain data about the indicated topics (in particular returns questions, answers and sources from which they are produced). Then the data obtained from the SFLM are sorted by the highest relevance R.

In the considered case, i.e. at the stage E1 of the process design, the teacher obtains the list of topics shown in Fig. 6. Among them are the following ones: dbms, relational database, sql, webshop. Results from the analysis of materials corresponding to these topics are presented in Table 1. The obtained sources allow one to prepare the Introduction stage (E1) of the lecture being prepared.

Based on the indicated materials the teacher selects the type of designed database (i.e. of the online store), customer requirements (e.g. selling different products in one order), and basic definitions (i.e. what is a database). This allowed him to prepare the E1 stage narrative.

The construction of the next E2-E11 stages is carried out in a similar way.

4. COURSE FLOW

4.1. Execute storyline

SBL's scenario is a realistic situation where a sequence of stages is presented and possible choices allow the learner to reach an outcome. Learning occurs when the user goes through the scenario and is guided to discover principles and develop critical competencies.

4.1.1. Guide students

The designed Storyline is a source of scenarios according to which the course can be conducted. The teacher plays the role of the moderator, introduces students to the context of the topic of the course and the goal they are to achieve. He activates the discussion and coordinates the work for the classes that their implementation is carried out in accordance with one of the envisaged scenarios. Students carry out classes in accordance with the adopted order. The transition from one stage to the next is conditional on the achievement of the stage goal (sub-goal, e.g. designing the structure of a database). Some steps require a decision the outcome of which determines the choice of the scenario pathway for the further implementation of the activities. The teacher should initiate this type of discussion and allow students to choose any pathway from a set of acceptable variants. If the chosen pathway leads to wrong results (the goal of the lesson will not be achieved) students have the opportunity to learn about the consequences of their decisions and take appropriate corrective actions (i.e. back to the right pathway). Classes are carried out until the adopted goal is achieved.

EXAMPLE

The teacher assumed that the activities will be carried out in accordance with the prepared Storyline presented in Fig. 7. The class group includes 52 students of the 3rd year. According to the adopted storyline, classes begin at stage E1 (introduction).

The teacher formulates the problem concerning the generalized question: How to build an online application? In order to show how to solve it, he/she is based on an arbitrarily chosen example (real example). Assumed example includes a company for which an IT system should be built as well as a kind of webshop application intended for instance for shop with customizable gifts. Students start their preparations by analyzing the available database systems as to know which solutions should be chosen.

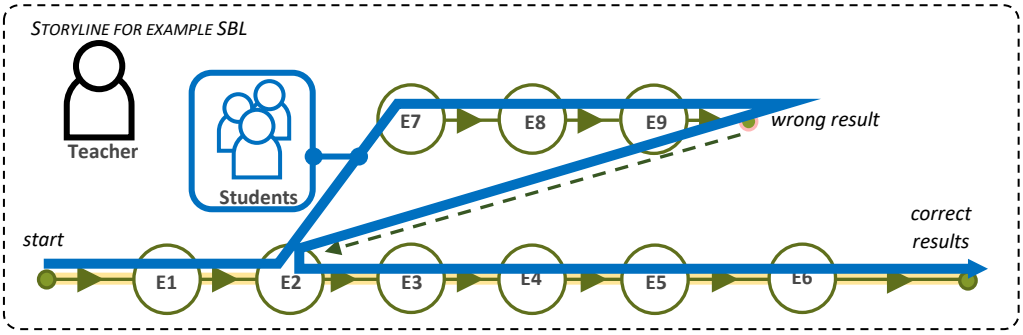


Fig. 7 The steps used in above example illustrating scenario design.

In the next stage (E2) the teacher starts an introduction to the subject area. He/she starts providing all the available information, for instance presenting the offered products on the website of the sample wholesaler and/or catalogues with offers from different manufacturers. The teacher also presents an example of an order form that is filled out by a customer. Consequently, students indicate the basic entities (the words underline in this paragraph), on the basis of the information provided. At this stage, students make decisions about the structure of defined entities.

The choice of students means that the rest of the classes are carried out according to an alternative pathway (E7-E9 see blue line in Fig. 7), the result of which is an incorrectly designed database. During stage E9, the students discuss corrective actions (pathway E3-E6), the implementation of which will enable the database design that meets the customer's requirements. The final stage (E6) of the course is verification of the achieved learning outcomes.

4.2. Assess

4.2.1. Choose an assessment method

Storyline is usually designed in such a way that the final stage allows the lecturer to judge the achievement of the assumed learning outcomes. Due to the type and subject of the classes, the lecturer may choose many options. These are among others:

- the multiple-choice tests,
- written exams/oral exams/ open-book exams,
- computer-based assessment,

- take-home exams,
- tested for instance learners' knowledge of the terminology they have learned,
- self-solving a sample project.

The adopted form of assessment should be adapted to the mode of conducted classes (synchronous/ asynchronous), student experience and the technical possibilities available (multiple-choice tests can be executed in using paper or electronics forms).

EXAMPLE
The last stage of the designed storyline is stage E6, which involves the verification of the accepted Learning outcomes. The teacher assumed that the students would be assessed on the basis of projects carried out at home. Students were divided into groups of 3. Each group was assigned a related task to the design of the database. The teacher gives oral exams in which each group presents its project and responds to the questions asked by the teacher.

5. GOOD PRACTICES AND TIPS

- Does not design too complex storyline (usually a storyline should not have more than 3 pathways).
- Allow students to go beyond the planned framework. Student invention can be the source of a new scenario.
- Avoid too many stages. A small number of stages allows for more flexibility in conducting classes.
- In the stage where the decision should be made, suggest the wrong solution first. This will allow students to look for their own solution.

6. REFERENCES

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