

Personalized Dynamic Learning Plan Generator for Smart Learning Environments

G R Anil, Salman Abdul Moiz

Abstract: Transition of traditional online learning towards the Smart learning environments requires adaptation of the smart features. Personalized assistance is one of the most required characteristic. Learning plans are important building blocks for any teaching learning paradigms. Often an instructor makes a learning plan keeping stakeholders into consideration. However in an online learning environment the stakeholders are not able to adapt to these static plans as there is no personalization involved. As a result there is a considerable increase in dropout rates. Hence there is a need for adaptive learning plans which aims for dynamic adjustment of schedules/learning plans that may help in successful completion of course. This paper presents an approach for dynamic learning plan generator and also proposes a revised Learning plan template to achieve personalized assistance in Smart learning environments. The responses of stakeholders on traditional learning plans and that of individualized dynamic learning plans are received. The response depicted that almost 90% of the stake holders feel that the adaptive learning approach aids in successful completion of the course along with improved motivation levels.

Index Terms: Dropout rate, Learner-centric Instruction, Learning plans, Motivation, Personalized learning, Smart Learning Environments

I. INTRODUCTION

Smart learning environment is the one that is effective, efficient and engaging [24]. The goal of a smart learning environment is to provide self-learning, self-motivated and personalized services [25]. Existing online learning is not smart enough to accommodate the required smartness levels proposed by Uskov et al[21]. The personalized assistance is one of the essential characteristic for Smart learning environment.

Dropout is one of the major constraints faced by the e-learning industry. To reduce the dropout rate, personalized assistance must be provided to the students who are especially at the risk zone[7]. There are various personalized methodologies for recommendation and prediction available in the literature. Predicting methodologies proposed by C. Taylor et al.[9] S. Halawa et al[2], Ya-Han Hu et al[5] assesses and predicts the performance of students with various machine learning techniques. However these Predicting algorithms are limited to estimate the future performance [3] followed by reporting to teacher/manager. Further they do not provide instructions for improvement to the student automatically.

Online courses have specific course duration which is realized by the course beginning date and course completion date.

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Especially paid courses, semester wise courses, competitive exams training courses do have a last date to finish. Each online course contains set of activities stored in several formats [16][17]. Online courses activities as described by Wella et al.[22] include lecture videos, documents/notes, questionnaire/quizzes/tests, etc[8]. Each activity should be completed by learner within the deadline of the course. Each activity is assessed formatively and summatively. Eg: For uniform assessment, rubrics [14] are used for evaluation. In such a scenario, we need a plan to fulfill all these activities.

Online courses have course plans which are common for all students. Each Learning Management systems [10][11][12][23] support the common static course plans i.e a fixed course plan common for everyone . As mentioned by D.F.O. Onah et al[6], when the dropout rate is high, a common plan is not sufficient as people delay in completing the activities most of the time. This constraint is the source of motivation for design and implementation of Personalized Dynamic Learning plan with the timely instructions. The plan is adaptive in nature which aids in successful completion of the course.

The Dynamic Learning Plan Selector(DLPS), Dynamic Learning Plan Generator(DLPG) algorithms serve the purpose. These algorithms consider the Course records, learner's records and deliver the individual learning plan for the user. The DLPS invokes the necessary actions to be taken and DLPG generates the individual learning plan. A new personal learning plan template is designed to accommodate different versions of the individual learning plan. It provides clear guidance/instructions to learners with respect to each activity in the course and the schedule to be followed.

The proposed algorithms are simulated with 390 stakeholders. Their responses about traditional online learning experience are compared after introducing the Individual dynamic learning plan. It is observed that 71.74% stakeholders got motivated, 89.5% of stakeholders responded that it is useful for completing the online courses on time.

This paper is organized as follows: Section II deals with the related work in the Learning plans domain, Section III discusses the DLPS, DLPG algorithms and proposes a revised template, Section IV presents experimentation results and Section V gives Conclusion followed by Future Scope and References.

II. RELATED WORK

Online courses often tend to suffer from significantly higher dropout rates as compared to the courses with face-to-face interaction [2]. D.F.O Onah et al[6] observed that the Successful course completion rate is below 13% in Massive Open Online Courses. Personalized assistance for the learners who are identified at a risk of dropout will reduce the dropout rates[7][8].

There are several Predicting methodologies like C.Taylor[9], S. Halawa et al [2] and others in the literature. Most of them send recommendations for the administrators or course instructors for providing assistance but could not integrate the automated Learning plans. As per Chang et al[1] “there is need for a reform, innovative uses of emerging pedagogical approaches and technologies, and sharing and promoting best practices, leading to the evolution, design, and implementation of smart learning environments”. Few Learning Management Systems support the learning plans in various forms. There are some guidelines proposed by the educational pioneers about the individualized learning plans but mostly these plans are predefined.

Australian Capital Territory Education and Training proposes the Guidelines [20] for personalized learning plans with a template provided. It is a static template, where the teacher needs to manually crosscheck with the learning outcomes regularly. Practically its not possible in a Massive Open Online Courses to monitor manually. Though the guidelines are professional, implementing them in online learning environment requires an updated template with automatic / dynamic instruction delivery.

The ‘Individual learning plan to personalize the teaching and learning program’, a template proposed by the school [15]. In this template, report of each student about their strengths and weak areas are observed, whereas instructions for students are not specified. It is a predefined one, which cannot accommodate any modifications and instructions for course activities.

OpenEdx has Progress Indicators [23]. It shows the quantity of the completed activities and the deadline. It provides a Grading Chart, which reports the score per activity in that course. But it does not provide an alternate plan to complete the activities once a student is out of the schedule. This does not provide a dynamic learning plan, thus a new feature is required for dynamic instructions. Personalized learning plan for every student proposed by “A How-to Guide from Edmentum[4]” is represented in Fig. 1.

Figure 1 Personalized learning planning worksheet from Edmentum

Template in Figure 1 is a basic one, which records the user interests and Goals. There is involvement of instructor and the learner, which practically is not possible for any MOOCs. As more and more students enroll to a course, individual attention by instructor becomes more difficult.

III. DYNAMIC INDIVIDUAL LEARNING PLAN

Each Learning Management System has options to provide Course plan or learning plan for each course [11][12]. Teacher or administrator of the course decides the schedule of the course which includes commencement date, duration and the deadline or the due date.

A typical learning plan (static) is depicted in Figure 2.

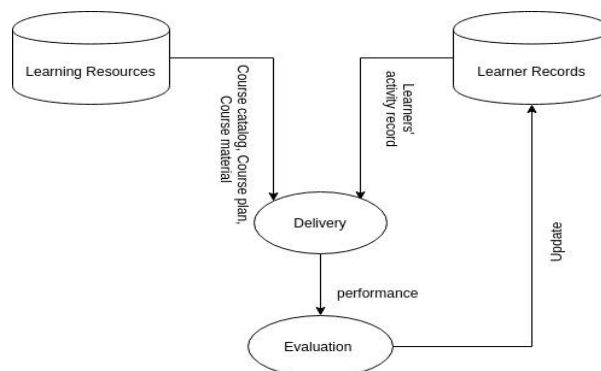


Figure 2 Workflow of static plan

In a traditional online learning content is delivered to the learner alongside the static course schedule. The Course schedule is a basic entity for all learners. Thus it is stored as part of the Learning Resources. Course schedule comprises of the course commencement date, ending date and weekly/timely activities. In the Course duration time, learner performance is evaluated and gets stored in the Learner Records [13]. After the course due date, the course fruition criteria is checked. Learners, who have satisfied all course exercises, will be qualified to get a course fruition endorsement. On failing to complete activities within the given time makes them ineligible for course completion endorsement. This static plan does not monitor the progress of the participants. If any person fails to complete a task within the stipulated time period, the amount of pending tasks increases. A learner has no clue, how to finish the past activities and current activities. The Learner gets demotivated if the course is not completed thereby resulting in dropping the course.

To address the above issue Dynamic Individual Learning plan is proposed. It screens each learner activity status (completed / yet to be completed). If a learner misses an activity, then the learning plan dynamically adjusts with respect to the deadline/due date of the course. It presents a clear plan to complete the work to be done per day and each day schedule. Thus, systematically all course activities and exercises can be done within the given schedule.

A. The Dynamic Learning Plan Workflow

The dynamic learning plan (DLP) helps in adjusting the schedule which is adaptive to the learner's individual progress.

The proposed approach can be adapted to any smart learning platform. The Methodology for dynamically updating and upgrading of the plan is presented in Fig. 3.

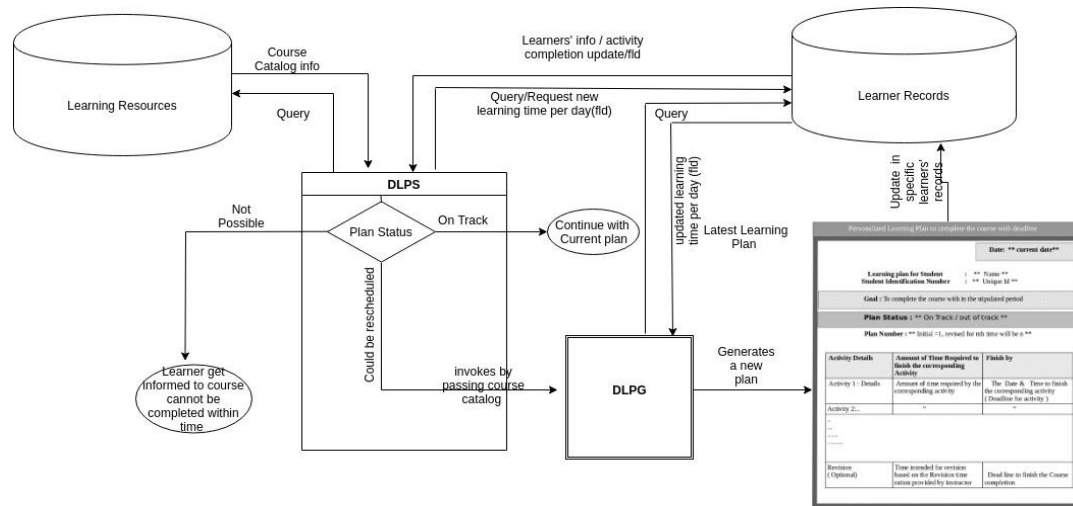


Figure 3 Workflow of Dynamic Learning Plan

Learning Resources and Learner Records are the data stores in the IEEE Standard for Learning Management Systems Architecture [11][18][19]. Learning Records contains the stakeholders profile details, courses enrolled, assessment reports, course activity tables, etc. Generally a course plan is stored in the learning resources. It is proposed to include a new entity named learner plan which has to be included in learning records to facilitate individual learning plan. This entry has its significance, as a static plan is common for a course and an individual learning plan is specific for each learner. DLPS gets invoked, whenever a learner's activity gets updated (viewed/completed/etc). The initial course plan is stored as "current plan" for each learner. There are three possible scenarios while generating a learning plan,

1. A learner following the "current plan" successfully
2. A learner is out of track/ not following the current schedule, but rather, there is a scope for completing the course with increased feasible learning time per day (*new_fld*)
3. A learner is out of track and there is no scope for completing the course, thus a learner is informed that there is no abundant amount of time available to complete the course.

DLPS addresses each scenario and proceeds with necessary actions.

When the learner is following the current plan as per schedule then no action is needed. Otherwise the status is set to "Could be rescheduled" and the learner is informed that the feasible learning time per day (*fld*) i.e. the amount of time that can be spent per day needs to be readjusted. Based on the "*new_fld*" value given by the learner, it is decided whether the learner can still complete the course within time. If so, DLPG is invoked. If not the status is set to "Not possible" and the learner is informed about the same. DLPG generates a modified personalized learning plan and the same is updated in the corresponding learner's record. An updated plan with the modified schedule is presented to the learner so that the course can be completed within the stipulated schedule.

B. The Dynamic Learning Plan Generator (DLPG) algorithm

The Dynamic Learning plan algorithm is adaptive in nature and it considers all possible scenarios. It consists of two routines

namely: Dynamic learning plan selector (DLPS) and Dynamic Learning plan generator(DLPG). DLPS evaluates the current scenario through the Plan status which leads to the following possible cases.

Case 1: Plan status = On Track

Action: Current plan is continued

Case 2: Plan status = Could be rescheduled

Action: Learner is out of track with their learning plan. There is a possibility for the Learner to complete the course, if they can increase the amount of time that they can spend on learning per day. In such a case, a new plan is generated by invoking DLPG. This can be controlled by the LMS admin, by placing a threshold. This threshold can be decided based on average amount of time that one can spend on electronic devices and time available to complete the course

Case 3: Plan status = Not possible

Available time duration may not be sufficient for completing the course. The user is informed about the same. Practically, this could save the efforts of the learner so that one can decide for opting for the course in future.

Data: Course details: Course Deadline *DL*, Current Date *CD*, Total content hours *TCH*, Remaining Days '*RD*', '*n*' is the number of course activities, Remaining content hours '*RCH*', Course Activity details $C = [a_1, a_2, a_3, \dots, a_{n+1}]$, time required for each activity $T = [t_1, t_2, t_3, \dots, t_{n+1}]$ where t_i is the time required to complete activity a_i , User '*u*' details from learner's records like Activity Status, Plan status '*PS*', Plan no '*P*', Feasible learning time per day as '*fld*'

Result: Individual learning plan


```

(RD * fld = RCH)
then
  Continue with the current plan, Plan status remains
  "On Track"
else
  PS? "Could be rescheduled" ;
  new_fld? read new_fld from u;
  if(RD * new_fld = RCH)
  then
    PS? "Could be rescheduled";
    Fld? new_fld
    call DLPG();
  else
    PS? "Not Possible";
    Inform u that with new_fld course cannot be
    completed
  endif
endif
end

```

Algorithm 1: Dynamic learning plan selector

The DLPS algorithm takes the latest feasible learning time per day (new_fld) as input and checks the possibility of course completion. If a plan needs to be generated for the first time or updated, it invokes the Dynamic Learning plan Generator algorithm (DLPG).

Data: Course details: Course Deadline DL, Current Date CD, Total content hours TCH, Remaining Days 'RD', Remaining content hours 'RCH', 'n' is the number of course activities Course Activity details $A = [a_1, a_2, a_3, \dots, a_{n+1}]$ time required for each activity $T = [t_1, t_2, t_3, \dots, t_{n+1}]$ where t_i is the time required to complete activity a_i , User 'u' details from learner's records like Activity Status, Plan status PS, Plan no P, Feasible learning time per day as d , per day scheduled hours 'PSH' Result: Learning plan with scheduled duration for each activity

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Update RCH by adding the duration of unexplored
activities  $a_i$  in A
 $P \leftarrow P + 1$ 
 $RD \leftarrow DL - CD$ 
for  $i \leftarrow 1$  to  $n$  do
  if (activity  $a_i$  is not completed in A)
  then
    assign the 'x' number of days for that activity such that
     $x = \frac{H_{TCH}}{H_{TCH}} * ???H$ 
  endif
endif
endfor
Update the Learning plan parameters in Learner's records
Export the learner plan details to Learning plan Template
and display

```

Algorithm 2: Dynamic learning plan Generator

The Individual learning plan is displayed to the user with the new proposed template. It is designed to facilitate the required plan numbers and the regularly updated activities and corresponding time schedule for each pending activity. This template discards the activities which are already completed and displays the updated plans.

C. The Dynamic Learning Plan Template

Traditional learning plan templates [15][20] does not support the activity based schedule for the individual learner. To accommodate personalized activity based learning plan, a new template is proposed.

The transition from traditional learning plan generator to that of a dynamic learning plan requires minor changes to the learning plans. The proposed template for personalized learning plan is represented in Fig. 4.

Personalized Learning Plan to complete the course with deadline

Date: ** current date**

Learning plan for Student : ** Name **
Student Identification Number : ** Unique Id **

Goal : To complete the course with in the stipulated period

Plan Status : ** On Track / out of track **

Plan Number : ** Initial =1, revised for nth time will be n **

Activity Details	Amount of Time Required to finish the corresponding Activity	Finish by
Activity 1 : Details	Amount of time required by the corresponding activity	The Date & Time to finish the corresponding activity (Deadline for activity)
Activity 2:..	"	"
...		
.....		
.....		
Revision (Optional)	Time intended for revision based on the Revision time ration provided by instructor	Dead line to finish the Course completion

Figure 4: Dynamic Learning Plan template

This template consists the timely targets for each activity. The components of the template are explained as below *Current date* Indicates the date on which the plan is generated. As the plan is generated dynamically current date turns into an important factor Goal specifies the Course details for which the plan is generated. Plan Status can be any one of On Track, Could be rescheduled, Out of track.

On Track indicates that the learner is following the prescribed learning plan and the course can be completed.

Could be rescheduled status represents that the learner has due on some activities, and alert learner about the current status. But, they can be covered with increased learning duration per day.

Out of Track indicates that course cannot be completed with the available time, thus learner can stop attempting on the last moment

Plan number indicates the number of times the plan being updated after activities are not finished based on the previous plan.

Activity Details describes the course activities which are not yet finished. Amount of time required to finish the corresponding activity indicates the duration of that each activity mentioned in the first column.

Course completion day / Course deadline indicates the tentative deadline for each activity.

Revision indicates the proportion of total learning content hours can be allot- ted for revision. This is added as a new activity in the course activities. By default, it is assigned with 10 % of actual content hours. This is optional and can also be declared by the instructor.

Dynamic learning plan Template is the amalgamation of the traditional and advanced features. Each course activity which is due by the learner is presented in their individual learning plan. This provides clear instructions for the learner. The impact of this template on learner motivation is discussed in the Findings IV.A.

IV. DATA COLLECTION & DEMOGRAPHIC PROFILES

Survey of Student Learning Plans is conducted by E-learning Research Group, School of Computer and Information Sciences, University of Hyderabad. 390 participants from the Research Scholars, Post Graduates, Undergraduates, Software Industry Employees, and



others have participated in the survey and expressed their views on the Learning Plans Usability.

The questionnaire provided to stakeholders with the static online learning plan includes the following questions [With out Dynamic learning plan i.e. Learners has only Static Course plan]

1. User details
2. Have you ever participated in an eLearning course?
3. If yes, choose the platform you have registered? [Moodle @ SCIS,UOH / Course era/Udemy/Khan Academy /NPTEL/Udacity/OpenEdx/Others]
4. Was there any Learning plan /Schedule provided to you? [Options: Yes / No / I am not aware of Learner Schedule]
5. Do you think, your progress is monitored by the course administrator/teacher?
6. Do you think your course is personalized and specific instructions are provided to you separately?
7. Was there any instrument which motivated you to follow the course schedule?
8. Do you postpone works when they are not much important at that time [Options: Yes / No / Sometimes]
9. Will it be convenient to complete a huge task, if it is divided into several guided short tasks within a notice period [Options: Yes / No / May be]
10. Did you ever registered for an online course and left without finishing it (till certification)

The following questionnaire is provided to above stakeholders after introducing the dynamic individual learning plan for the online courses [With Dynamic Learning Plan].

1. Do you think that your progress is monitored after going through the Learning plan template/ you experience personalized learning?
2. Will the Learning Plans motivates learners to finish the tasks with short-term goals? Look into the Learning Schedule for individual learner [Options: Yes / No / Maybe]
3. Do you feel that the Learning Plan/ Preparation schedule Useful for students Note: Please refer to the above image for Learning plan template [Options: Yes / No / Maybe]

A. Findings

The number of samples collected was 396. Out of which 315 people had participated in at least one online course. Survey results state that 288 stakeholders could not finish the courses in which they registered, i.e. 91.4 % dropout rate, which reflects that successful course completion rate is 8.6% only. This has drawn special attention to look into the reasons which lead to such dropout rate. Stakeholders' response is collected with the traditional learning plans. Later the individual learning plan is introduced, their response is again taken. The correlative analysis has revealed the following.

The analysis of dropout rates when static plan is adopted is presented below

- People responded that 195 out of 315 were provided with the course plan (weekly plans/ monthly plans), which is common for every course participant.
- 195 respondents out of 315 were aware of course learning plan, the remaining respondents are not even aware of such plans
- 88% of respondents felt that their individual performance is neither monitored not observer by the administrators or teachers which was the reason for their low confidence.
- 86.98% of respondents feels that there no instrument in the course which motivates them to finish it on time. The basic reason for lack of confidence among the stakeholders is due to unavailability of personalized learning plans that increased the dropout rates. The individual dynamic learning plan is introduced to address these issues.

Individual Dynamic learning plan was introduced to the same respondents and the following results were obtained

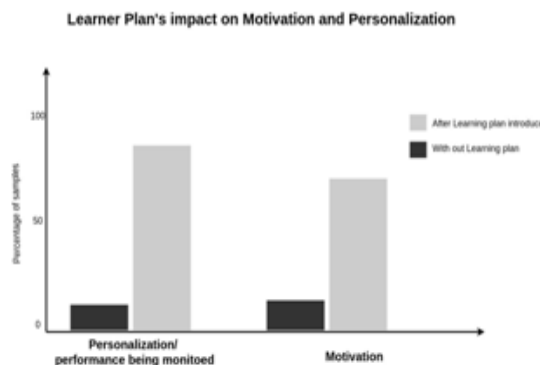


Figure 5: Dynamic Individual Learning Plan's impact on Motivation and Personalization

- 71.74% of respondents claimed that they got motivated by the short term goals for each activity in the learning plan
- 88.97% of respondents feel that their course is personalized and their individual performance is monitored.
- 89.5% of respondents gave their feedback that individual learning plans are useful/helpful in online learning.

All the LMSs available in the literature uses course plans which are designed at the inception of the course. As the learning platform not smart enough to motivate the learners, dropout rate is huge. After introducing the individual dynamic learning plan, it is observed that 89.5% of stakeholders are of the opinion that individual learning plans are useful in completing the courses.

V. CONCLUSION AND FUTURE SCOPE

Smart learning environment involves effective and efficient learning through personalized assistance. An effective learning is possible only if the learning plan is designed properly. Introduction of the static learning plans at the time of commencement of course does not help the slow learners to complete the course in the stipulated time. This is one of the reasons for increased dropout rates. The proposed dynamic individual learning plan motivates them to complete the online courses on time.

Dynamic Individual learning plan can also be adopted for blended learning. Individualized dynamic learning plan can act as a component to the existing Learning management systems architecture. Further individualized instructions generator modules can be added as components or services to the learning management systems architecture. These components can take individual strengths and interests for proceeding towards learner-centric online education.

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