Enhance Classroom Preparation for Flipped Classroom using AI and Analytics

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Keywords: Chatbots, Digital Assistants, Intrinsic Motivation, Classroom Preparation, Flipped Classroom.

Abstract: In a flipped classroom setting, it is important for students to come prepared for the classroom. Being prepared in advance helps students to grasp the concepts taught during classroom sessions. A recent student survey at Fachhochschule Nordwestschweiz (FHNW), Business School, Switzerland, revealed that only 27.7% students often prepared before a class and only 7% always prepared before a class. The main reason for not preparing for classes was lack of time and workload. A literature review study revealed that there is a growth of the use of Artificial Intelligence (AI), for example, chatbots and teaching assistants, which support both teachers and students for classroom preparation. There is also a rise in the use of data analytics to support tutor decision making in real time. However, many of these tools are based on external motivation factors like grading and assessment. Intrinsic motivation among students is more rewarding in the long term. This paper proposes an application based on AI and data analysis that focuses on intrinsically motivating and preparing students in a flipped classroom approach.

1 INTRODUCTION

As described in (Bishop and Verleger, 2013), the flipped classroom approach is a student-centered learning approach, in which the traditional teaching is reversed (see Figure 1), in the sense that students are:-

- Exposed to the learning content outside of the class via videos or articles.
- Provided with out of class or online opportunities to interact and discuss the material with fellow classmates.
- Utilizing their class time to understand the knowledge through discussions, problem based learning and presentations.

In a flipped classroom, students are expected to come prepared to the classroom sessions. Preparation includes reading articles, watching videos and multimedia content, preparing presentations, taking short quizzes and having discussions with fellow classmates (Lo, Hew and Chen, 2017; Sheppard et al., 2017). The learning materials and outside class activities can be delivered via online systems like learning management systems etc. (Caligaris, Rodríguez and Laugero, 2016; Wang, 2017; Yilmaz, 2017). In case method-teaching (Hammond, 2002) students are expected to study real life case studies in
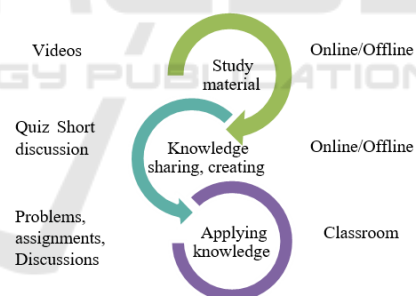

Figure 1: Different stages involved in flipped classroom setting interpreted from (Bishop and Verleger, 2013; Caligaris, Rodríguez and Laugero, 2016; Wang, 2017; Yilmaz, 2017).

details and discuss the case informally with their peers before coming to the class. In classrooms, the students bring their own analysis and try to defend their own perspectives about the case. A recent survey conducted among the higher degree students of FHNW School of Business revealed that only 27.7% students often prepared before a class and only 7% always prepared before a class. According to a study by PwC in (PwC Digital Services, 2017), more than half of the candidates believed that AI had great potential in delivering personalized and adaptive

education to students and that use of AI-based digital tutors will be on the rise in the coming 5 years. Please refer Figure 2. Similarly, there is a growing interest in teaching analytics, which supports the teacher awareness, reflection and decision making in both physical and virtual classroom environments (Mclaren, Scheuer, and Mikkátko, 2010; Vatrapu *et al.*, 2011; Holstein, McLaren and Aleven, 2017). Tools like teachers dashboard are being developed to support decision making of teachers by providing them with actionable insights of students learning activities in real time (Tissenbaum *et al.*, 2016; Holstein, McLaren, and Aleven, 2017). Based on the results of the survey and the literature review we present the argument that AI based tools along with data analytics would help build the intrinsic motivation of students for classroom preparation in a flipped classroom setting. It additionally offers the opportunity for teachers to personalise, adapt the teaching to the interests and weaknesses of the students, and focus on topics that are not clear to them. The paper initially presents the results of the survey at FHNW and of the literature review. Later it presents the concepts related to the AI based application to support classroom preparation in a flipped classroom setting.

2 RESEARCH PROBLEM

According to a recent survey conducted among 140 postgraduate students of FHNW School of Business, 56% of the students only prepare sometimes for the classroom sessions while 8% of students do not prepare at all. Only 27.7% students prepared often while 7% students always prepared for a class.
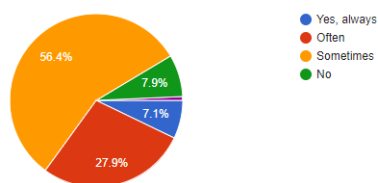

Figure 2: Statistics for classroom preparation at FHNW.

Nearly 88% of students attributed to lack of time as the main reason for not preparing regularly for the classroom. Other students felt that classroom preparation is not necessary as they already had knowledge about topics; some topics were too difficult to prepare on their own; that teachers will anyways teach the concepts in class. Nearly 51% of students were of the opinion that pre-classroom preparation would help them to be more engaged in classroom sessions. Students also specified other reasons separately (as comments) for not preparing for the classroom. They are mentioned in table 1 below.

Table 1: Few categories of students' comments.

No	Categories for not preparing for class
1.	Lack of motivation/interest
2.	Workload of other assignments and work
3.	Material not provided well ahead in advance
4.	Not aware of what to prepare exactly

Although studies (Taha *et al.*, 2016; Lo and Hew, 2017) suggest that use of flipped classroom approach does improve student learning experience and outcomes, it still has some issues and challenges. As per the study of (Lo and Hew, 2017) in K-12 education, 1) teachers workload of preparing for flipped classroom materials increases considerably, 2) students are less engaged in or skip out of the pre-class activities, 3) pre-class preparation had caused many of the students to be dissatisfied. At the same time, the lecturers expect to motivate and engage students in classrooms. In a one-teacher classroom, it is not always possible for lecturers to give personalized attention to each student (Holstein, McLaren and Aleven, 2017). The lecturers thus expect to understand beforehand the doubts and confusion of students so that they can prepare ahead for the class (Benotti, Martínez and Schapachnik, 2014; Pereira and Juanan, 2016; Holstein, McLaren and Aleven, 2017). (Tileston, 2010) suggests that students learn well and are more interested in learning when they are intrinsically motivated. Intrinsic motivation is the inner drive that motivates students to pay more attention to the learning (Tileston, 2010; Perlman, 2013). External motivations based on reward systems like marking, giving bonus points, grading for participation etc. only help students temporarily to be engaged in learning and is not healthy in long-term learning (Tileston, 2010). It is possible to build intrinsic motivation in students by using effective teaching and communication techniques (Seifert, 2004). Most of the flipped classroom approaches use external/extrinsic motivation factors like assessment/grading for classroom preparation. Based on this students consume the preparation material because they are rewarded with grades (Elliott and Rob, 2014).

(Maderer, 2017) reports that in spring of 2016, two AI based assistants were introduced at the Georgia Tech University in the United States by a professor in an online course on Artificial Intelligence (AI). One bot named Stacy interacted with students during class introductions and posted weekly updates while another one named Ian answered routine questions of students. At the end of the class, it was observed that students were more engaged in the current class than last semester, as there was a rise in a number of comments and online interactions with the AI chatbots. The teacher attributes this increase in interaction partly to the AI tutors, as they were able to give fast response to the students than their human assistants.

The main aim of this research work is to 1) improve the intrinsic motivation of students 2) help students and teachers to prepare well in a flipped classroom setting 3) investigate how AI and data analytics can be used for enhancing classroom preparation. In order to carry out the research work, following research questions have been derived. The main research question is:

How to build intrinsic motivation of students and help them as well as teachers to prepare effectively in a flipped classroom setting?

Sub-research questions are as follows:-
- What are the requirements of students for classroom preparation in a flipped classroom setting?
- What are the requirements/expectations of teachers for classroom preparation in a flipped classroom setting?
- How to build intrinsic motivation among students?
- How can AI and data analytics be used to help students and teachers prepare ahead for the classroom?

3 LITERATURE REVIEW

Chatbots or bots can hold intelligent natural language conversations with humans in an engaging manner. These conversations can be either text-based or voice-based (Fryer *et al.*, 2017). Due to these features of chatbots/bots, it makes them a good candidate as assistants to students as well as teachers in the learning as well as teaching processes. For example, chatbots have been used to practice English language lessons with students (Fryer, 2006; Ayedoun, Hayashi and Seta, 2015; Fryer *et al.*, 2017). In a

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[1] Differ bot studied from the website https://www.differ.chat/

recent article (McNeal, 2017), chatbots seem to reduce the workload of the teachers by answering the routine questions asked by students and prompt them to complete the assignments on time. In past few years, chatbots (Pereira and Juanan, 2016) have come up with more advanced features. Using machine-learning techniques, these bots can track the progress of the student's assignments and quizzes and tests and inform the students in a friendly and motivating language to take an appropriate action if they are lagging behind. Similarly, they can also inform the teachers about the student's progress (Pereira and Juanan, 2016). There is a growing evidence that use of chatbots/bots motivates the students for learning and keeps them engaged in the learning process. Following are few examples of some implementations of chatbots.

@DAWEBOT is a bot discussed in (Pereira and Juanan, 2016), that provides quizzes in form of conversations with students. The bot helps students to take quizzes. After the quiz, it gives feedback to students about their results and understanding of the topic via a web dashboard. Teachers can also find how students are mastering each topic and to which extent the topic is understood by students. This bot was tested with 23 students of computer science for a 15-week class. After completion of the course, 89% students thought that using bots for practicing a test as a good idea and almost 72% students thought that the bot helped them to be more engaged in their subject. However, this chatbot was meant to practice questions for the real exam and is thus based on external motivation factors like assessment, grades etc.

Differ[1] (Differ, 2017) developed by EdTech, is a bot based application that engages the student with the course material. It automatically recommends and makes groups of students and kick-starts the group discussions by posting introductory messages in chat groups. It helps students with assignments by giving hints or nudges i.e. subtle messages with a recommended set of actions to complete their assignment. As per their website information, students felt more engaged with the content and felt more comfortable while asking repetitive questions to the differ bot. However, the chatbots in Differ only kick-start the student conversations and do not really seem to actively participate in them (see figure 3).

Student interaction and learning data logged in the technology enhanced learning systems has the potential to reveal insights about learner's activities (Tissenbaum *et al.*, 2016). Many learning

environments now display learners and teachers dashboards and visualizations that provide actionable insights about the state of the whole class as well as individual student performance for teacher decision making and providing adaptive feedback (Vatrapu *et al.*, 2011; Tissenbaum *et al.*, 2016).
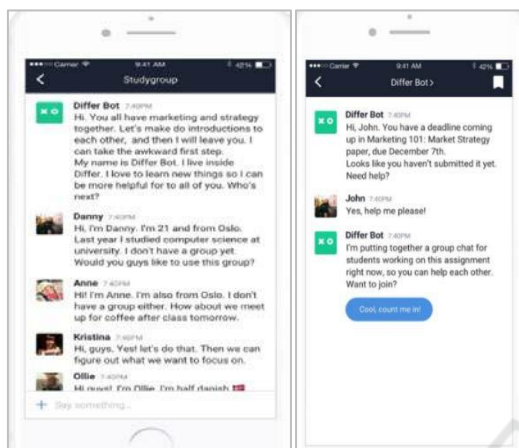

Figure 3: Differ bot for introduction in groups and assignment help (from https: //www.Differ.chat/bots).

Perusall[2,3] is an eBook based learning platform that allows students to prepare online before classroom sessions. Students read and annotate online articles with comments that can be shared with the other fellow students. Students could also ask questions; discuss answers with their peers related to the annotations or contents of the online book. This chat data is analysed to detect the student's doubts, confusions and interests and this information are reported to teachers in the form of confusion reports. However, Perusall does not have support for generating auto conversations. It has a grading system that grades the annotations and questions and answers of the students in the online book. Hence it is based on external motivation factors like assessment, grading. It is lightly based on intrinsic motivation as it allows student interactions.

The literature review thus describes the latest tools that support student preparation and their shortcomings. In the discussion phase, we suggest the concept of an application based on AI chatbot and data analysis that support students classroom preparation, builds intrinsic motivation among students and gives feedback to teachers for classroom preparation.

4 DISCUSSION

In this research work, the focus is to enhance the classroom preparation in a flipped classroom setting and build the intrinsic motivation of the students. Based on the results of literature review it is observed that use of chatbots engages and motivates students in learning process. As per research by (Klemm 2002), conversations are important for knowledge exchange and motivating people. Conversations between students-students, teacher-students contribute to learning and knowledge. This research also suggests that written form of conversations are more impactful as writers are more intensely engaged in the content while writing. For this purpose, we want to build an application that includes a conversation-based chatbot that will assist the students and teachers in preparing for the flipped classroom.

In order to build such an application, we follow the design science approach. As mentioned by (Hevner and Chatterjee, 2010; Carcary, 2011), design science is problem-solving research field that involves designing and developing innovative artefacts for real-world complex business problems. It is aimed to design and build artefacts that are effective in solving problems. The design artefact in this context is "Intelligent application for classroom preparation in flipped classroom approach". In the awareness phase, the interviews and surveys have been conducted to understand the exact needs of classroom preparation of students and teachers. In the suggestion phase, the requirements and features of the application will be defined. Figure 4 depicts a conceptual design of the application. This application is a platform that includes a chatbot, a data analysis engine and a dashboard for student and teacher recommendations. The platform can integrate the data from different sources like student profiles, learning management system, course data etc. The main purpose of the bot will be to introduce the students for the topics of the upcoming class by 1) engaging them in small group text based discussions on class topics, 2) answer students question about topics that are relevant to preparation tasks given by teachers.

The inbuilt chatbot will trigger short conversations or interactions about classroom topics among students and actively participate in such activities.

In order to generate the conversations/interactions, the chatbot will refer to the course content data. Moreover, lecturers will be able to easily configure the bot to trigger appropriate
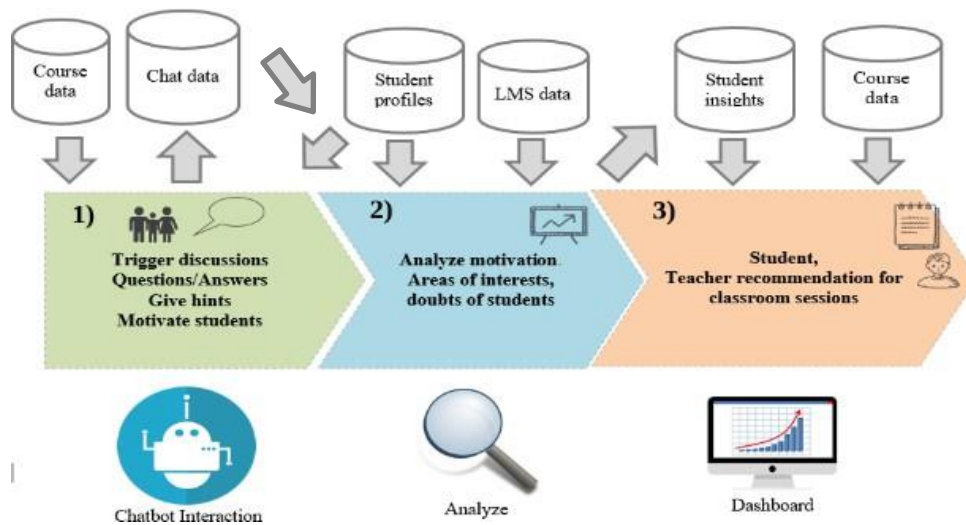

Figure 4: Concept of chatbot supported application for classroom preparation in flipped classroom (Free graphics used from https://pixabay.com/).

conversations or interactions for the classroom preparation. In order to make student groups for group conversations/interactions, the bot will first assess profiles of students and take into account factors like past experience, similar interests, diversity etc.(Srba and Bielikova, 2015). This will create a diverse group of students that could generate an interesting mix of conversations.

After the interaction, the conversation data will be analysed in real time to find the doubts, motivation, interests of the students. Dashboard features will be provided to students to track their progress for classroom preparation. While lecturers will be provided with the information about student's motivation level, doubts, and questions. Based on these insights the chatbot will also give suggestions to lecturers on teaching strategies and tips to prepare the classroom material (e.g. presentations) for the upcoming class. By knowing the doubts of students, the lecturers can adapt their teaching methods and content in a timely manner. Please refer Figure 4 for the chatbot application features. Over the period, the bot shall learn more about the student's personalities from the accumulated student's insights data. This data will help the bot to predict when and where each student might need help during subsequent classroom preparations. This will give way to more personalized support to students. In future, there could be multiple instances of chatbots that could automatically cater to personalized preparation needs of different students.

5 FUTURE WORK

The research work until now identified the research problem and the design artefact that we want to build for classroom preparation in the flipped classroom approach. In the next stage, i.e. in the suggestions phase, we want to build the exact requirements or design of the classroom preparation application. Figure 5 depicts the boundary of the classroom preparation application along with the goals, inputs/outputs, and conversation-based features. The inputs to the application can be preparation goals and input materials provided by the teacher. The goals can be giving students highlights of the next class; basic concepts of the session; short assignments etc. The input material given for preparation can be text-based materials at the start. In future, we can consider video/ and audio materials. For generating conversations we also need to decide the actors, activities, and scenarios. For example, the actors can be the bot and the students. The bot can do the group formation of the students for the activities based on their profiles etc. The scenarios depict how the bot will engage in the conversation-based activities with the students. The bot can serve as 1) a conversation initiator 2) a conversational mediator 3) a recommender for completing tasks/activities. The output of the system can be the learning outcomes achieved by the students. Key performance indicators like motivation and engagement will also be defined during this phase. In order to define scenarios and activities, we will conduct expert interviews with lecturers to find learning activities that could be delivered via the bot
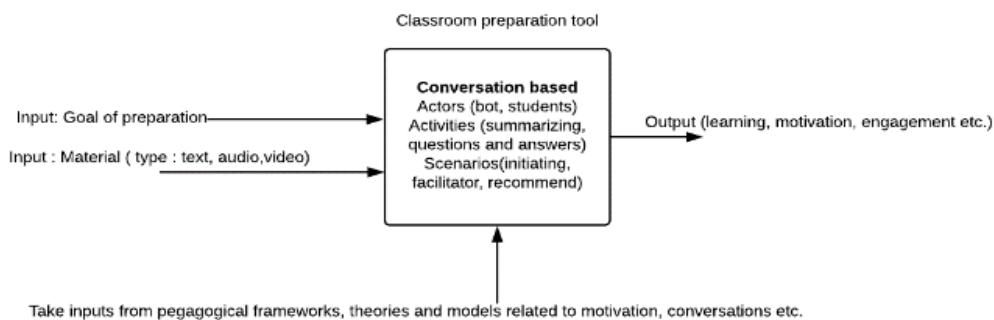
Figure 5: Defining the goals, input/output, actors, activities and scenarios of the system.

based application. We will do a literature review to understand which learning activities/processes are effective for flipped classroom and how best they can be supported by the application. For example, we will be investigating theories like **Self-Determination Theory (SDT)** for building intrinsic motivation (Ryan and Deci, 2000) and **Speech act theory** (Searle, 1969; Winograd and Flores, 1986; Colombetti and Verdicchio, 2002) while designing the conversations based activities/scenarios in the bot based application. The proposed application will be developed using agile methodology (Dingsøyr, Dybå and Abrahamsson, 2008). At first, the application prototype will be built with the few set of features, scenarios and evaluated in actual class settings at the degree programs at FHNW School of Business. The students will use the tool for class preparation, and the conversations will be analysed and KPI's like engagement etc. will be measured. At every stage, the results from the evaluation will be considered for the design and development of the subsequent prototype.

6 CONCLUSIONS

Classroom preparation is important in a flipped classroom setting. From the student survey results at FHNW and literature review results, it is clear that many students do not prepare for classrooms sessions in a flipped classroom. Literature review suggests that intrinsic motivation building in students is more rewarding than external motivations like grading, assessments etc. Good conversations among students facilitate learning and increase their motivation. The existing tools dealing with classroom preparation focus mostly on extrinsic motivation factors like grading, exams, and assessment. With the rise in AI technologies, chatbots are being used as students and teachers assistants to facilitate the learning and teaching processes. The research paper proposes an initial concept of chatbot supported classroom

preparation application that will enhance the outside class student preparation process and build the intrinsic motivation of students by engaging students in short interesting conversations about classroom topics. Moreover, this application will also help the teachers to prepare in advance for the class by understanding students doubts and weaknesses.

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