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# A chatbot for building intrinsic motivation among students in a flipped classroom setting.

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"I dedicate this Ph.D. research to my Guru Shree Lord Krishna, and for the welfare of humanity".

## Abstract

The thesis aims to build intrinsic motivation among students in the flipped class by using a chatbot. In flipped classes, sometimes students face low motivation due to a lot of preparation content. Due to low motivation students often skip preparatory learning assignments, a phenomenon that is observed both in literature and a real-world case study. Intrinsic motivation is important for good learning outcomes. Starting point of the research are three approaches that are mentioned in the Self Determination Theory. This theory states that feelings of autonomy, relatedness, and competency enhance intrinsic motivation among subjects. Peer modeling enhances intrinsic motivation among students by showcasing the learning experiences of similar professional and educational backgrounds of students. Organismic Integration Theory states that by explaining the importance of a learning topic students choose to study the topic autonomously thereby enhancing intrinsic motivation. The use of chatbots with intrinsic motivation-building factors from theories like Self Determination is on the rise in a flipped classroom. The goal of the research is to incorporate the motivation-building factors of "*peer modeling*" and "*explain the importance of learning topics*" in chatbot design for building intrinsic motivation among students in a flipped classroom.

The thesis follows the design science methodology to build an innovative chatbot named Flippy with the above intrinsic motivation-building factors for the students learning in a flipped classroom. The chatbot is evaluated by forty-three students. The students gave a survey-based rating based on the Intrinsic motivation inventory as per Self-Determination Theory. Many students agreed to have experienced the feeling of autonomy (63 % agreed) and relatedness (84 % agreed) during chatbot interaction. The relatedness is concerning the friendly and easy-going nature of the Flippy chatbot. Autonomy is concerning the flexibility given by the chatbot to students to explore the learning topic as per their choice and pace. Students agreed to experience fun (43 % agreed) and developed interest (42 % agreed) in the learning topic during chatbot interaction. The feeling of interest is a direct indicator of intrinsic motivation. A comparatively smaller number of students experienced negative feelings of anxiety (5% agreed) and pressure (21% agreed) for homework after chatbot interaction. The chatbot scored less in terms of competency feeling among students concerning confidence in their skills (32% agreed) and confidence to prepare for the topic (26% agreed) and inspiration to prepare (28% agreed) after watching peer experiences. The students liked the features of customization, the significance of the topic, and peer modeling the most in the given order. The reward section was liked by fewer students. Sixty-five % of students said that they would like to use Flippy again while 35% said they won't like to use it again. The overall student response to the Flippy chatbot was positive. Many students (42%) showed signs of intrinsic motivation in learning the topic. To further increase intrinsic

motivation and especially the feeling of competency among more students some enhancements can be done to the chatbot design. For example, providing more video peer model experiences at the start of chatbot interaction in the main menu. This provides more autonomy to students, and they get inspired by students' experiences at the start without having any preconceived notions about the learning topic. From student surveys, many students gave their preference for the use of video-based examples for peer experiences. Also, providing more than one peer model experience enhances the feeling of self-efficacy among students.

The chatbot features and the design guidelines provided in the thesis will help the tutors, chatbot designers, and researchers to incorporate factors of peer modeling and explanation of the importance of topics in combination with other intrinsic motivation-building design factors in their chatbot designs. These guidelines also include suggestions for enhancements and hints to improve the existing chatbot features based on the feedback and opinions of the students provided in the evaluation surveys and interviews.

Keywords: Chatbot, flipped classroom, intrinsic motivation, peer modeling, Self Determination Theory, autonomy, competency, relatedness

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# Chapter 1: Introduction to the topic and research problem

There is a rise in the use of Flipped Classroom (FC) method in higher education systems like universities in bachelor's and master's degree programs (Al-Samarraie, Shamsuddin and Alzahrani, 2020). A Flipped Classroom (FC) is a pedagogic learning technique in higher education (Al-Samarraie, Shamsuddin and Alzahrani, 2020). In the FC method, students take accountability for their learning and prepare for the lesson outside the classroom mostly at home (Abeysekera and Dawson, 2015). Students prepare by either reading materials, watching videos of the learning instructions, or taking at-home quizzes (Bishop and Verleger, 2013; Winquist and Carlson, 2014; O'Flaherty and Phillips, 2015; Christiansen *et al.*, 2017), while in-class time is mostly for problem-solving and group work where students apply their knowledge learned outside class with the guidance of the tutor (Bishop and Verleger, 2013; O'Flaherty and Phillips, 2015; Lo, Hew and Chen, 2017). The flipped class technique has its benefit as it makes students take responsibility for their learning and progress (Khodaei *et al.*, 2022). But on the other hand, the workload of preparation for students increases in a flipped classroom (Khanova *et al.*, 2015; Bouwmeester *et al.*, 2019). Sometimes due to workload and low motivation levels, students skip learning activities in the flipped class (Tangkittipon *et al.*, 2020).

Motivation is the inner drive of humans to perform a task or activity (Tileston, 2010). Intrinsic motivation is the internal interest of human beings to do any task or activity (M. Ryan and L. Deci, 2000). It makes humans do tasks out of interest and satisfaction (M. Ryan and L. Deci, 2000). Extrinsic motivation is dependent upon external factors like grades, regulations, etc. Intrinsic motivation is long-lasting and is linked to better learning outcomes, good grades, and student engagement than extrinsic motivation (Taylor *et al.*, 2014; Froiland and Worrell, 2016). The success of FCs mostly depends on the high motivation levels of the students (Johnson, 2013; Taylor, 2015). Intrinsic motivation or interest in FC preparation will inspire students to study at home for the flipped class. Self Determination Theory (SDT) states that intrinsic motivation can be built by supporting the psychological needs of autonomy, relatedness, and competency (ARC) in humans (M. Ryan and L. Deci, 2000; Trenshaw *et al.*, 2016). Autonomy is the sense of freedom in students to take charge of their learning as per their choice and speed (Trenshaw *et al.*, 2016). Relatedness is a factor where people adopt the values and practices of people and groups to whom they feel emotionally connected (Niemiec and Ryan, 2009). Competency in students is the feeling that they can perform a learning task /challenge or undertake learning lessons successfully (Trenshaw *et al.*, 2016).

## Problem statement

Peer modeling (PM) is a motivation-building factor where students are motivated by knowing other students' experiences of learning (Schunk, 1987; Ohtani *et al.*, 2013). Students think that they will also be able to perform the task successfully like their other similar peers (Bandura, 1986, 1997; R Lepper *et al.*, 1993; McQuiggan, Mott and Lester, 2008). Researchers have suggested that peer modeling can be used to create a perception of optimal challenges (Belland, Kim and Hannafin, 2013). Optimal challenges are the ones that are neither simple nor challenging and are known to build competency in students (Di Domenico and Ryan, 2017). Despite having the potential to build a feeling of competency in students PM is not properly utilized in software learning systems to help students in perceiving how simple or challenging a task is (Belland, Kim and Hannafin, 2013). The chances of students completing the task successfully increase when they perceive the task as doable or optimally challenging (Lo and Hew, 2017). Also, students would feel connected to the experiences of their senior peers if their peers' faced challenges and overcome them during their learning thereby promoting the feeling of relatedness and self-belief (Schunk, 1987; Kichiji, 1997; Murphey and Arao, 2001). Giving real-world usage examples of concepts is highly motivating and inspiring to students if the task that they are doing is impacting their work or an organization in a positive way (Hewlett, 2009; Pink, 2009). Hence peer models can narrate experiences or examples where their work related to their learning topic positively impacted an entity or society.

As per Organismic Integration Theory (OIT), if students understand the importance of certain activities as important for their learning, then they will endorse these goals/activities and make them a part of their learning habit by choice (M. Ryan and L. Deci, 2000). When such a person regulates learning by integrating new values and actions then the person's learning is more self-determined and can lead to intrinsic motivation (M. Ryan and L. Deci, 2000). We can simply call this factor *explaining the importance of learning topics to students* i.e., EILT. Ideally, researchers recommend that teachers should explain the significance of learning topics to students (Kusurkar, Croiset and Ten Cate, 2011). Along with this explanation, it will be beneficial to students to learn how past students applied those learning concepts in their professional and educational assignments to create a positive impact. This will motivate students to learn the topic by free choice rather than under pressure.

There is a rise in the use of advanced technical tools like conversational chatbots in the educational field and especially in FCs (Winquist and Carlson, 2014; Hew *et al.*, 2021). In the FC, chatbots are mostly used as virtual assistants (Hew *et al.*, 2021) to support students to take quizzes, setting and following learning goals (Hew *et al.*, 2021), answering questions/FAQs, and providing help in solving case studies (Huang, 2019). These features are thus supportive

of preparatory activities in an FC context. Chatbots are also found to build intrinsic motivation among students while imparting learning instructions. In the literature review chatbots are seen to promote the three intrinsic motivation-building factors and feelings of ARC among students. In chatbot-based learning, students felt a higher feeling of autonomy while using the chatbot as they thought they could control their learning at their own choice and pace and could ask questions, do quizzes, and could get immediate constructive feedback on their performance (Yin *et al.*, 2021). Chatbots provide tools to build skills (for example language learning) and give immediate constructive feedback to students (Fryer, 2006; Pereira, 2016). These features help to build competency in students. Chatbots can detect students' emotions from their conversations for example boredom, and anxiety, and provide personalized emotional support to students (Winquist and Carlson, 2014; Garcia Brustenga, Fuertes Alpiste and Molas Castells, 2018). This promotes a feeling of relatedness among students concerning the chatbot. For designing the intrinsic motivation building chatbots, chatbot designers have proposed certain guidelines that are based on the SDT (De Vreede, Raghavan and De Vreede, 2021; Yang and Aurisicchio, 2021). The focus of these researchers is on the features that promote the ARC's emotional needs based on the SDT (De Vreede, Raghavan and De Vreede, 2021; Yang and Aurisicchio, 2021). Despite having the conversational abilities and potential features to build intrinsic motivation we don't see any integration of PM and EILT features in chatbots for building intrinsic motivation among students in flipped class contexts. In the flipped class teachers also have a high workload as they need to prepare out-of-class learning materials for students (Lo and Hew, 2017). A chatbot thus can be used to deliver peer modeling and EILT features to students to motivate them to prepare well for the flipped class topic. The teachers can then focus on the work of teaching the important concepts in the learning topics. Chatbots could deliver the peer model experiences to students to motivate them to learn the topic in the flipped classroom context. But currently, we don't see any chatbot narrating or delivering the peer modeling experiences of the students to motivate and inspire students to study for the flipped class in the literature review.

The focus of the thesis is thus to investigate and demonstrate the incorporation of PM and EILT factors into the chatbot features for building student intrinsic motivation in the flipped class context. For carrying out the research work the thesis incorporates the design science research methodology which focuses on developing a research artifact in this context a chatbot that addresses the student motivation issues in the flipped classroom. To define the focus of the research, the research question is defined so that further research is conducted in the specific area to search for the results. Following is the main research question of the research work in this Ph.D. thesis: -

"How can the peer modeling (PM) experiences and the importance of learning topics (EILT) be used to intrinsically motivate students to prepare for the flipped class setup using a chatbot?"

The research question has two types of variables. These are namely independent variables and dependent variables. The independent variable is the one that is changed or manipulated, and the dependent variable is the observed change due to manipulation or changes brought about in the independent variable (Yegidis, Weinbach and Myers, 2018). There are two independent variables namely the PM and the factor of EILT that will be incorporated into the chatbot features to build intrinsic motivation (dependent variable) among students concerning FC preparation. The dependent variable is the intrinsic motivation among the students of the flipped class. This intrinsic motivation is related to the interest in learning the topic and to the use of the chatbot for FC preparation. The main research question is answered by the suggestion and development phase in Chapter 5.

To support the main research question following sub-questions are derived: -

1. What motivational challenges are observed during the preparatory phase in a flipped classroom?
   - ✓ This question is answered by the literature review in section 2.1.2
2. What are important theories and factors significant for intrinsic motivation?
   - ✓ This question is answered by the literature review in sections 2.2, and 2.3 in detail. While a high-level summary of these factors is given in section 2.4.
3. What are the state-of-the-art design factors concerning the use of chatbots for enhancing intrinsic motivation among students in education field?
   - ✓ This question is answered by the literature research in section 2.5 and its sub-sections in detail.
4. How to evaluate a chatbot that uses factors like PM and EILT to help in class preparation and to build intrinsic motivation in the FC?
   - ✓ This question is answered by evaluation chapter 6.

The focus of the thesis research is on how chatbots will convey or deliver the peer model (PM) concepts and explain the importance of topics (EILT) to the students to build intrinsic motivation among students in FCs. While designing such a chatbot existing design factors for chatbots concerning intrinsic motivation will be considered from the existing knowledge base from the literature. The proof of concept will be built for a specific flipped lesson in the Business Intelligence class in the Master of Science in Business Information Systems at FHNW. The developed chatbot will be tested in a real-world flipped context and its effect on the intrinsic motivation of students will be analysed.

## 1.1 Thesis structural outline

In this section, we look at the structure of the thesis. The thesis is organized into different chapters, sections, and sub-sections. Following are the high-level structure and brief descriptions of the respective chapters.

1. The literature review chapter starts with an introduction to Flipped Classroom (FC), the technology used in FC for learning, and the motivational challenges faced by the students in the FC. Next, it contains an introduction to the theories of intrinsic motivation namely: Self Determination, Organismic Integration Theory, Optimal Challenges, and Peer modeling. Next, it focuses on the use of chatbots and their features for promoting intrinsic motivation among students. In the end, it discusses the research gap found in the literature review.
2. The research methodology chapter presents the design science research methodology that is used for conducting the thesis research work along with the explanation of its different phases namely the awareness, suggestion, development, and evaluation.
3. The FHNW Case study chapter contains the description and analysis of the results of the different student surveys conducted at the FHNW master's degree programs. It also includes an analysis of different study documents and the learning management system used in the flipped classroom.
4. The chatbot for increasing student motivation chapter describes the high-level chatbot concept along with screen designs and its proof of concept. It also gives the generalization and benefits of the proposed chatbot along with the technical feasibility of different technical components. It also provides the proof of concept for the similarity mechanism for Peer Modeling (PM).
5. The evaluation of the proof of concept chapter contains the chatbot test in the flipped class of Multidimensional Modelling and the discussion of the scored results in the test and control group surveys and open-ended interview results. The open-ended survey and interview answers of students contain the student feedback and suggestions for improvement for the proposed chatbot. Based on the student feedback the guidelines to develop the proposed chatbot are presented.
6. The conclusion chapter contains the important results and contribution of the thesis work followed by the study limitations and future work.
7. Appendices contain extra detailed information about different survey questions and answers and interview questions conducted concerning the thesis research work.

# Chapter 2: Literature Review

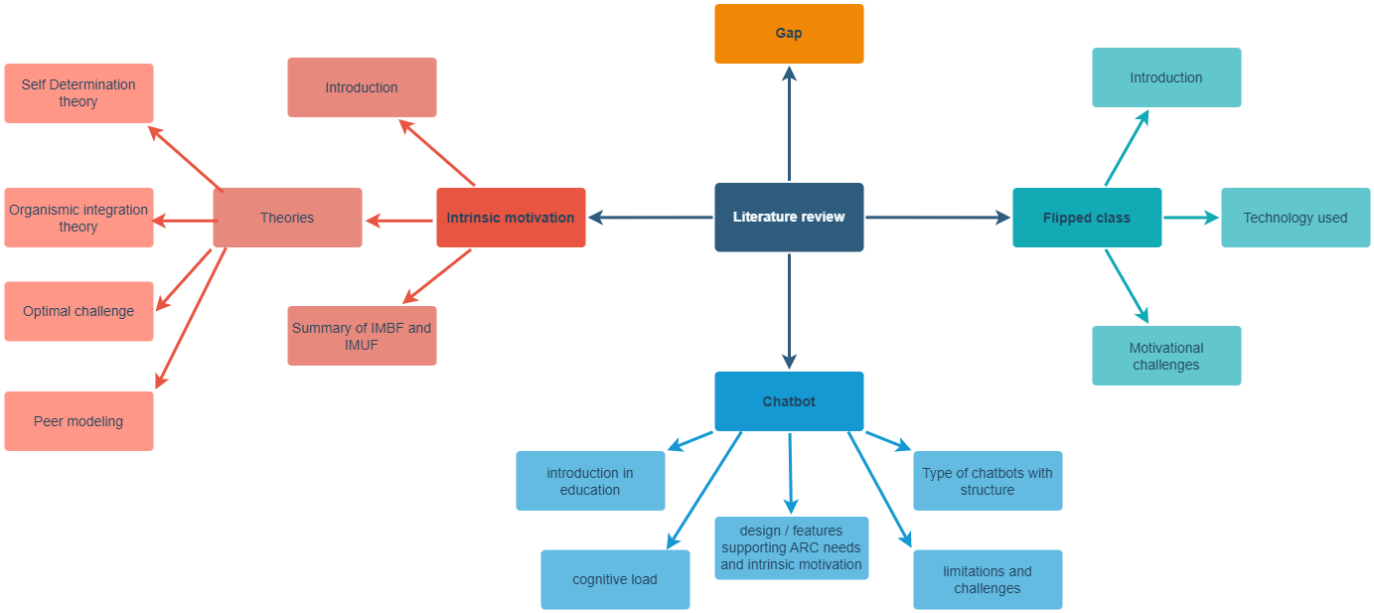



Figure 1 Structure of the thesis literature review

Figure 1 above shows the different sections and sub-sections and their relevant topics in the literature review chapter. The literature review first focuses on the motivational challenges faced by students in flipped classroom settings from the literature review. Next, it defines different types of motivation and analyses and describes the core intrinsic motivation theories for example *Self Determination Theory (SDT), Organismic integration theory (OIT),* and *peer modeling (PM)* concepts. It looks at factors that enhance as well as undermine intrinsic motivation among humans. Intrinsic motivation in education is required for a long-lasting and quality learning process among students. The literature review presents an analysis of the different intrinsic motivation-building factors (*IMBF*) and intrinsic motivation-undermining factors (*IMUF*) from the main motivation theories in the literature in a condensed view/format. With the recent advancements in *Artificial Intelligence* and conversational interfaces, there is a rise in the use of chatbots and/or conversational agents in educational settings (Winquist and Carlson, 2014). It has been observed from the literature review that efforts are being made to design different conversational agents/chatbots based on different IMBF factors from well-known theories like the *SDT* of intrinsic motivation (De Vreede, Raghavan and De Vreede, 2021; Yang and Aurisicchio, 2021). Such chatbots are found to enhance the three psychological needs that enhance intrinsic motivation among students namely perceived *autonomy*, *relatedness*, and *competency* (*ARC*). The literature review also focuses on some chatbots that are specifically been designed for flipped classes (Hew *et al.*, 2021). After this, the chapter presents the design factors in chatbots from the literature review

that promote intrinsic motivation among students in flipped classroom contexts. At last, the literature review discusses the research gap that is found in the field of chatbots that are aimed to build intrinsic motivation among students. Based on this research gap the further foundation of the research work is based and carried out. At every level of the literature review, the thesis presents the research artifacts or condensed reports for the relevant context.

## 2.1 Introduction to the flipped classroom

In the most recent times of the COVID-SARS-2 pandemic and lockdown, there is a steady increase in the use of flipped classroom (FC) techniques combined with technology and online learning environments to deliver learning experiences to students (Campillo-Ferrer and Miralles-Martínez, 2021; Gopalan, Butts-Wilmsmeyer and Moran, 2021; Khodaei *et al.*, 2022). During this time, some students' responses to the FC techniques were positive mostly due to the self-directed and autonomous learning facility that is provided (Khodaei *et al.*, 2022). It was found that some students adjusted well to the FC techniques and their semester scorings were comparable to last semester's face-to-face FC classes. It was additionally found that FC settings promoted motivation and awareness in students about their cognitive capabilities during the covid times (Campillo-Ferrer and Miralles-Martínez, 2021; Gopalan, Butts-Wilmsmeyer and Moran, 2021; Khodaei *et al.*, 2022). The FC technique is not recent but is being used for the last decade. Educational institutions are getting a lot of attention, as the need to improve student performances and demonstrate program effectiveness is on the rise (O'Flaherty and Phillips, 2015). To foster students' participation and engagement in their learning activities educational institutions are implementing active learning techniques in the classroom. In the active learning process, the focus is on students taking charge of their learning tasks and activities rather than keeping the focus on traditional classroom-based lectures where teachers provide lectures (Abeysekera and Dawson, 2015). An FC is such an example of an active learning technique. Research suggests that there is a rise in the popularity and use of FC techniques in higher education (O'Flaherty and Phillips, 2015) and will continue to rise post covid times as well. In an FC, the students prepare outside of class by mostly watching pre-recorded lectures. The classroom time is spent in group discussions, solving problems, and practicing tasks with the help of the tutor (Bishop and Verleger, 2013; O'Flaherty and Phillips, 2015; Lo, Hew and Chen, 2017). An FC is aptly defined by Hamdan et. al (Fallatah, Jabbad and Fallatah, 2015, p. 4). "In the FC model, teachers shift direct learning out of the large group learning space and move it into the individual learning space, with the help of one of several technologies" (Fallatah, Jabbad and Fallatah, 2015, p. 4). Most FC has three stages in common. They are as follows as mentioned in Figure 2: -

1. Different types of FC have different materials like reading materials, pre-class quizzes, reading questions, and online learning videos. This material is provided before the class so that students could prepare the pre-requisite concepts for the traditional class (Bishop and Verleger, 2013; Winquist and Carlson, 2014; O'Flaherty and Phillips, 2015; Christiansen *et al.*, 2017).
2. Quizzes are also conducted in an FC to assess the mastery of the students over the out-of-class learning materials; to understand their doubts and common mistakes (Triantafyllou, Timcenko and Kofoed, 2015; Lo, Hew and Chen, 2017). Student-to-student discussions are promoted to create and share knowledge and to ask and clear doubts about assignments (Yilmaz, 2017). For such activities, a learning management system like Moodle hosts these preparation materials, videos, and group discussions (Yilmaz, 2017; Sergis, Sampson and Pelliccione, 2018).
3. The in-class time is then spent applying this knowledge in problem assignments and group discussions under the supervision of the tutor. In this way, tutors could detect any errors or shortcomings in the knowledge of students (O'Flaherty and Phillips, 2015).

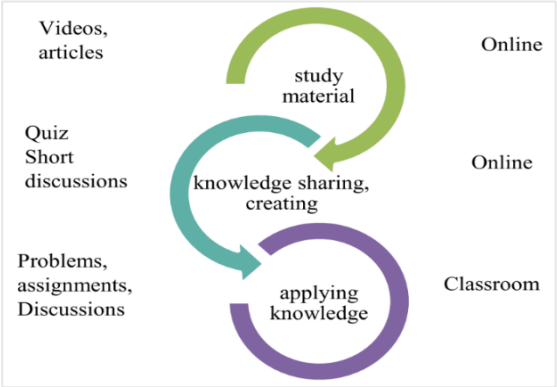



Figure 2 Stages of the flipped class derived from literature review

The FC pedagogic technique gives students the flexibility to do the homework at their speed and from any place (Taylor, 2015). The FC technique is effective in speeding student self-study as well as academic performance, deeper learning, higher student engagement, collaborative work, and enhancing the communication skills of students (Caligaris, Rodríguez and Laugero, 2016; Tan, Yue and Fu, 2017). Initially in the FC class, asynchronous video lectures were primarily used to teach concepts to students at home or out of class (Bishop and Verleger, 2013). But with the advent of new technologies, the flipped classroom has become high-tech. In the next sub-section, we look at the current state-of-the-art techniques used in the flipped classroom.

### 2.1.1 Technology used in the flipped classroom.

Apart from LMS, Intelligent tutoring systems (ITS) are being used in flipped classrooms (Mohamed and Lamia, 2018; Eryılmaz and Adabashi, 2020). An intelligent tutoring system is more than a learning management system. While the LMS helps in storing and creating different learning objects and delivers them to students using different delivery instructions. An intelligent tutoring system also provides such instructions and hosts learning materials, but it goes one step above and provides real-time expert help or scaffolding or guidance as a tutor to the students about problem-solving, learning instructions, and content. While it is possible to still connect with peers and tutors via chat module in LMS, this real-time automated expert help is not easily possible in an LMS (Daly, 2009; Mohamed and Lamia, 2018). In terms of problem-solving an LMS can provide the right-wrong answers to the problem and can allow customizing learning content (Daly, 2009). But in terms of problem-solving an ITS can provide intelligent guidance and feedback in the form of scaffolding and hints to students. It is found that scaffolding provided by an ITS brings out better learning outcomes in students, builds self-efficacy, and thus promotes motivation among them (McQuiggan, Mott and Lester, 2008).

In recent years, there is a rise in the use of chatbots or conversational agents in the education field mostly because they can hold intelligent conversations with users and they have intelligent abilities like customization of user experience, answering repetitive questions and doubts of users/students, twenty-four by seven student support (Winquist and Carlson, 2014; Garcia Brustenga, Fuertes Alpiste and Molas Castells, 2018). Because of these characteristics, chatbots are mostly being used in classroom learning both at the school and university levels mainly for practicing foreign language learning by students (Robino, Torsani and Ravicchio, 2020); for answering students' doubts and questions about class topics (Winquist and Carlson, 2014; Maderer, 2017); for delivering micro/ small and focused learning instructions to students (Yin *et al.*, 2021); used for reducing academic procrastination among students by nudging them to adopt good learning habits (Rodriguez, Piccoli and Bartosiak, 2019). There is evidence from the literature review that chatbots are also slowly being introduced in the flipped class formats mostly for answering student's basic questions, recommending additional learning materials to students (Tangkittipon *et al.*, 2020); and delivering quiz questions, and setting learning goals among students (Hew *et al.*, 2021). Students have found such chatbots useful and easy to use in the flipped classroom (Hew *et al.*, 2021).

Chatbots are found to be more advance than an ITS. An ITS delivers learning content or instructions to students and gives immediate feedback and is specifically related to a domain-specific knowledge base (Garcia Brustenga, Fuertes Alpiste and Molas Castells, 2018). While an educational chatbot holds an intelligent conversation with the student and analyses the

intent and emotions of the student and reacts synchronously and proposes appropriate learning solutions to the students (Garcia Brustenga, Fuertes Alpiste and Molas Castells, 2018). The chatbot allows the students to keep control of their learning activities and this is a major success factor for effective learning as per constructivist learning theory (Glasersfeld, 1987; Winquist and Carlson, 2014). Hence in the subsequent chapters in the literature review, we look at the different chatbot solutions/designs used in education processes, specifically flipped classrooms, and analyse how they can motivate and positively impact students in their learning activities (section 2.5). Despite all such advancements in technology used in FC, there is a chance of motivational challenges arising among the students. In the next sub-section, we look at such challenges in detail.

### 2.1.2 Motivational challenges in a flipped classroom

Despite having several advantages, the FC approach has certain disadvantages. With this method, a load of preparation increases outside class, and students do not come always prepared to the class (Herreid and Schiller, 2013). In some surveys, students complained about a high level of time investment in preparation and assignments for the class; technical problems related to online video lectures; and a large amount of group work (Triantafyllou, Timcenko and Kofoed, 2015). It was found that students in flipped classes achieved better learning outcomes when pre-class quizzes were added to some flipped lessons (van Alten *et al.*, 2019). However anonymous student surveys revealed that pre-class quizzes demotivated students' attendance of the classes and engagement in flipped classroom materials (Christiansen *et al.*, 2017). It is observed that all students did not go through learning materials and hence are unprepared and thus cannot participate well in classroom activities (Sayeski, Hamilton-Jones and Oh, 2015; Bouwmeester *et al.*, 2019). In the current thesis research work done at university degree courses at the School of Business at FHNW, Switzerland certain anonymous surveys were carried out to see if students prepared before the flipped class. It showed that only 27.7% of students prepared often and only 7% always prepared. The main reasons for not preparing were lack of motivation and interest; lack of time; more workload; no clarity on how to prepare. Moodle logs of the pre-class quiz were checked, and it was found that some students skipped some questions, solved some questions by trial-and-error method, or entirely skipped the quiz. The main reasons given by students for not taking quizzes well were lack of preparation, the complexity of some questions, and low motivation levels. The details of this are provided in the FHNW case study.

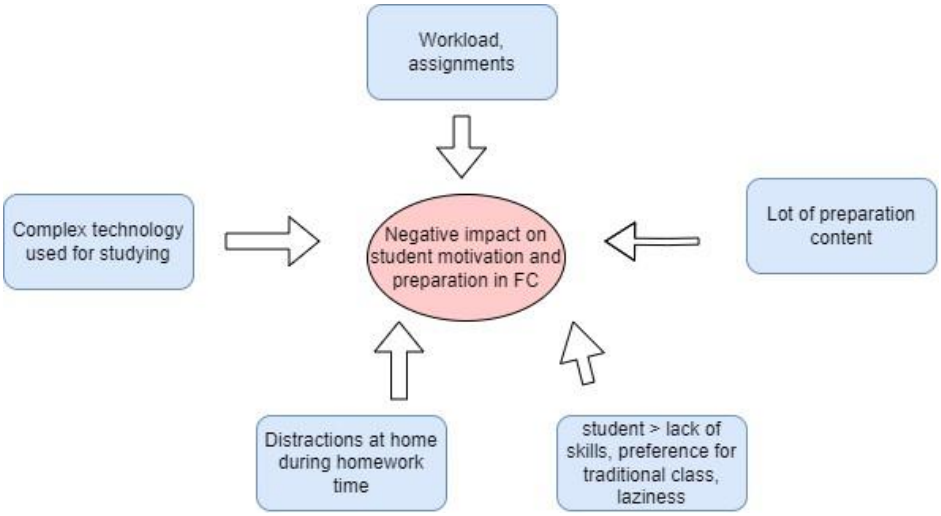



Figure 3 Factors impacting student motivation and preparation in a flipped class.

Figure 3 shown above gives the main factors found in the FC literature review that can undermine the motivation of students and affect their preparation for an FC. This artifact gives the important reasons that affect the motivation of students in a flipped classroom in a pictorial format. Each point is discussed in detail further below.

In student interviews at higher education at the University of Coventry, some students had negative responses to the flipped class approach (Taylor, 2015):-

1. Some students preferred face-to-face traditional classes and interaction with other students.
2. Some students lacked the motivation for self-study due to distractions at home.
3. Some students were too lazy to participate in the flipped class.

Students themselves can resist the flipped class technique if they think that the workload (a lot of preparation content and assignments) is very high or if they think that they don't have the necessary skills to do the task and thus can lose the motivation to do the homework (out of class) activities (Henderson and Dancy, 2007; Milman, 2012; Herreid and Schiller, 2013; Findlay-Thompson and Mombourquette, 2014; Moffett and Mill, 2014; Gilboy, Heinerichs and Pazzaglia, 2015; Jensen, Kummer and Godoy, 2015; Simonson, 2017). Student resistance can also be there if the FC is newly introduced, and they might think that the tutor is not teaching properly and the workload is not equally distributed among them (Frydenberg, 2013; O'Flaherty and Phillips, 2015; Simonson, 2017). Researchers (Kim *et al.*, 2014) in their research state students can have low engagement with preparation and need to be encouraged from time to time (Su and Chen, 2018). This is a result of low motivation among students as well as the high workload of preparation required for flipped classroom lessons (Khanova *et al.*, 2015; Bouwmeester *et al.*, 2019).

In an FC, students must do extra work using online learning techniques like videos, and LMS to do home assignments. But at the same time, the use of technology in flipped classes can also impact the motivation and learning of students if students are not ready to use technology or are incapable of using new technologies from home (Guglielmino and Guglielmino, 2003; Yilmaz, 2017). They might also feel that the new technologies are complex to use (Yilmaz, 2017). Some students might not easily adjust or feel comfortable with online learning as compared to traditional classroom learning (Taylor, 2015). Having self-efficacy in using a computer, the internet, and online communication, self-regulation helps in maintaining interest in the online homework activities at home. Thus e-readiness or willingness of students to use online learning technologies in flipped classes helps to maintain motivation and interest in learning (Yilmaz, 2017). Also, if the learning environment is not designed to motivate or stimulate the interest of the students in learning activities then the students won't be successful in their learning endeavors (Yilmaz, 2017).

The success of flipped classroom sessions mainly depends on the motivation levels of the students (Johnson, 2013; Taylor, 2015)(Simonson, 2017). If students are not motivated to prepare before the class, then they fail to understand the concepts in depth during subsequent classroom sessions (Johnson, 2013; Taylor, 2015). (Simonson, 2017) gives further hints that the intrinsic motivation of students is beneficial in flipped classrooms. A flipped classroom is an active learning technique where students in ideal conditions take the learning into their hands and prepare autonomously (Trenshaw *et al.*, 2016). Autonomy is an indicator of intrinsic motivation (M. Ryan and L. Deci, 2000). Furthermore, interested students would take up learning activities and homework. Inherent interest in studies or activities is another indicator of intrinsic motivation (M. Ryan and L. Deci, 2000). Hence intrinsic motivation is important from the perspective of flipped class technique.

In the next section, we look at the importance of motivation and specifically why intrinsic motivation is important for student learning. The thesis investigates different theories and factors that influence and undermine intrinsic motivation among students.

## 2.2 Introduction to intrinsic motivation

Motivation is the inner drive to do some activity or task (Tileston, 2010). It drives humans to study and do new things and encourages us to try again after failure (Tileston, 2010). Motivation is an important factor for student learning and success in education (Usher *et al.*, 2012) and it affects all phases of learning (Tasgin and Coskun, 2018). Motivation can affect every aspect of student life from how students relate to educational institutions and their tutors, and peers; to how much time and energy they give to studies; how they perform on assessments, and their academic achievements and success (Usher *et al.*, 2012). According to

Lumsden (Lumsden, 1994), a learning environment or classroom climate that makes students feel that they are valuable, and with a sense of belonging can have a positive impact on their participation in the learning process and thus build their motivation. A high level of motivation leads to better academic performance, a better understanding of concepts, academic success, self-esteem, social adjustment, and low dropout from educational institutes (Gottfried, 1985, 2009; Ryan and Deci, 2000a, 2009).

Motivation has three types namely amotivation, extrinsic, and intrinsic motivation (M. Ryan and L. Deci, 2000). Amotivation is a state where the subject lacks the intention to act or perform any activity (M. Ryan and L. Deci, 2000). Amotivation develops from not valuing the task at hand (Ryan, 1995) or lacking a feeling of competency (Deci, 1975) to perform it, or believing that the task will not give any positive outcome (Seligman, 1975; M. Ryan and L. Deci, 2000). Another type of motivation called extrinsic motivation is the one where the activity or task performed by the individual is for a separable outcome other than for the enjoyment of the task (M. Ryan and L. Deci, 2000). External regulation is extrinsic and is autonomously controlled by either punishment or rewards or grades (Ryan and Deci, 2020). For example, a student who does homework to avoid punishment or penalty because of fear of punishment. Introjection is an internal form of extrinsic motivation that is controlled by the inner ego where the self-esteem of the student depends on the outcome of the activity performed (M. Ryan and L. Deci, 2000; Ryan and Deci, 2020). For example, a student who studies a concept gets a good mark on an exam so that he will be appreciated by his peers (i.e., to build self-esteem).

On the other hand, Intrinsic motivation is doing any activity due to inherent interest or enjoyment of the activity (Ryan and Deci, 2020). Playful, curiosity-driven activities generate intrinsic motivation as they are relying on the enjoyment of the activity rather than being affected by any external rewards or pressures (Ryan and Deci, 2020). The phenomenon of intrinsic motivation was first acknowledged in experimental science where it was observed that many animals including humans exhibit curiosity-driven behaviours in their surrounding environments to get positive experiences and enhance their knowledge and capacities (Di Domenico and Ryan, 2017). Harlow (Harlow, 1950) was the one responsible to name the term *intrinsic motivation*. He observed that the primates or monkeys were showing spontaneous exploratory behaviours for puzzles and did not need any external rewards. And when they have given some external rewards their curiosity in the play was reduced. By nature, human beings are curious and playful (intrinsically motivated) by birth in their healthier states and do not need external incentives or rewards for this behaviour (Harter, 1978; M. Ryan and L. Deci, 2000). This nature allows humans to grow physically, socially, and cognitively and grow in knowledge and skills (M. Ryan and L. Deci, 2000). All human behaviours are motivated by

rewards like food or money, but in intrinsically motivated behaviours the reward is the enjoyment of the task or activity (Skinner, 1953; M. Ryan and L. Deci, 2000). Intrinsically motivated activities satisfy deep psychological needs (M. Ryan and L. Deci, 2000). According to research, humans learn not just by cognitive processes but by the desire to learn or by their inner self-system. This self-system is the motivational drive that drives learners to either take or give up the learning task (Tileston, 2010).

### 2.2.1 Benefits of intrinsic motivation

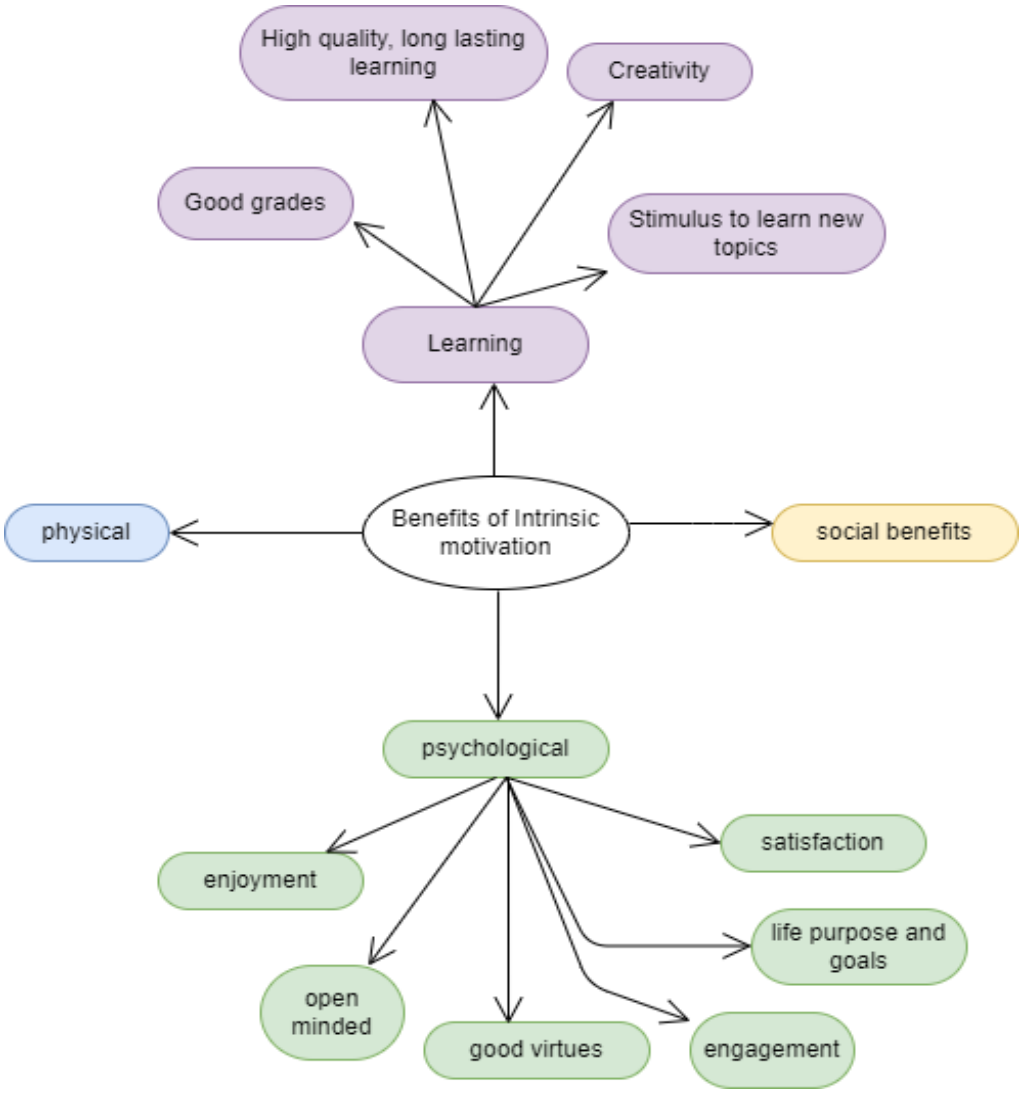



Figure 4 Contribution of intrinsic motivation to student learning and psychology

Certain benefits come along with intrinsic motivation. The above figure 4 gives the benefits of intrinsic motivation for students from the literature review as follows. Intrinsic motivation is associated with tasks that humans enjoy doing or find interesting and the satisfaction that they get out of it. Some people might be motivated to do tasks while not all people are intrinsically motivated for a particular task (M. Ryan and L. Deci, 2000). Further, Intrinsic motivation is

responsible for good learning and creativity in students, and it can be positively influenced or undermined by parents and teachers in students (Ryan and Stiller, 1991; M. Ryan and L. Deci, 2000). Intrinsic motivation provides stimuli to students to learn different subject areas and then to differentiate their interests as per their liking. This helps them to form their identities and goals and purpose in life (Deci and Ryan, 1985; M. Ryan and L. Deci, 2012; Di Domenico and Ryan, 2017). Constant dedication to learning intrinsic activities helps learning and growth, promotes the development of student personality, and makes them open-minded towards challenges and new ideas (Peterson, 1999; Di Domenico and Ryan, 2017). Scholars state that the intrinsically motivated study of one's interests and motivations helps to build the highest of human qualities for example wisdom among students (Habermas, 1972; Csikszentmihalyi and Rathmunde, 1990; Vervaeke and Ferraro, 2013; Di Domenico and Ryan, 2017). In history, intrinsically motivated people have done notable inventions. For example, Nikola Tesla was a great inventor and engineer, and he laid the foundation of the industrial revolution (Great Performers Academy, 2022). For him, it was of great interest to see his ideas take form and become a success (Great Performers Academy, 2022). Marie Curie was the inventor of radioactivity and a chemist and a physicist (Great Performers Academy, 2022). She was inspired by nature and was intrinsically motivated to do new inventions (Great Performers Academy, 2022). It was observed in the students at higher education and university level in various countries like Sweden, and Canada that high levels of intrinsic motivation were indicators of better academic achievements, good grades, and GPA [1] and indicated better student engagement in learning (Taylor *et al.*, 2014; Froiland and Worrell, 2016).

It has been also found that after early childhood, the intrinsic motivation of children starts to reduce mainly due to pressures from a society where they must do tasks and activities that might not be so interesting and must take on new responsibilities and roles (Ryan and Deci, 2000a; Ryan and La Guardia, 2000). Hence it is very important to study what factors influence and undermine intrinsic motivation in students. By looking at the various factors from theories of Intrinsic Motivation we can take necessary steps in teaching and designing appropriate learning environments. In the next few sections, we look at the different theories of intrinsic motivation and the factors that affect it.

### 2.2.2 Self – Determination Theory

Motivation in infants reduces every year of the student's academic life (Usher *et al.*, 2012). In the United States, more than 40% of high school students were inattentive or disengaged in learning, bored with studies, and put little effort into schoolwork in a survey conducted in 2004 (Usher *et al.*, 2012). Lower motivation leads to high school dropout rates (Usher *et al.*,

[1] A Grade Point Average (GPA) is an average of all grades got during course duration.

2012). In a survey in 2006, more than 60% of students reported that the reason for their dropout was due to low motivation (Bridgeland John J DiIulio and Karen Burke Morison, 2006; Usher *et al.*, 2012). Moreover, motivation also plays an important role in determining academic success and persistence at the college/university level education (Slanger *et al.*, 2015). Educational systems and reformists are investing money, energy, and time to improve the quality of teachers, curriculum, and assessments for raising student achievements. But better learning outcomes won't be possible if student motivation and engagement in learning activities are overshadowed (Usher *et al.*, 2012). Therefore, it becomes important to study the factors that enhance or undermine intrinsic motivation among students. By knowing and understanding these factors tutors can develop their lessons, learning content, and teaching methods and thus promote intrinsic motivation among their students. I conducted a literature review related to intrinsic motivation and identified the factors that positively affect intrinsic motivation among students. I call them the *Intrinsic Motivation Building Factors* (IMBF). The factors that negatively affect intrinsic motivation are called *Intrinsic Motivation Undermining Factors* (IMUF). This section discusses some of the important factors affecting intrinsic motivation.

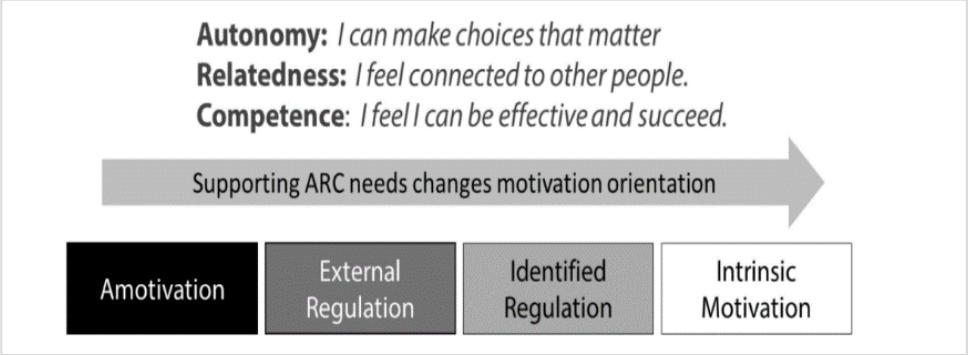



Figure 5: Self-Determination Theory and ARC needs *(Trenshaw* et al.*, 2016)*

The psychological needs of students are equally important as the cognitive processes of students (Deci and Ryan, 2008; Kadir *et al.*, 2020). The Self-Determination Theory [2] (SDT) tells that intrinsic motivation can be enhanced among students if the psychological needs of autonomy, relatedness, and competency (ARC) of students are supported during the learning experience (M. Ryan and L. Deci, 2000; Deci and Ryan, 2008; Trenshaw *et al.*, 2016). Several studies show that supporting students' ARC psychological needs leads to high academic motivation, high learning outcomes/achievement, and positive learning experiences among students (Jang *et al.*, 2009; Niemiec and Ryan, 2009; Ng, Liu and Wang, 2016; Trenshaw *et al.*, 2016). Please refer to Figure 5 above for the three important psychological needs described

[2] https://selfdeterminationtheory.org/ : This research work conducts research on human motivation in different fields like social, educational, technology etc.

in the Self-Determination Theory. Autonomy is the sense of freedom in individuals to make their own choices and proceed in whatever path they feel is the best for them (Trenshaw *et al.*, 2016). Autonomy in education is when students take charge of one's learning. Such students choose their topics for learning, acquire knowledge, and monitor progress on their own (McCrocklin, 2014). Competency is the feeling that an individual has the necessary skills and knowledge to achieve a particular task (Trenshaw *et al.*, 2016). Competence is related to a sense of mastery and that a person can learn and grow (Ryan and Deci, 2020). Relatedness is the sense where users feel emotionally connected to the actions and values of other users and endorse them as their own because of this connection (Niemiec and Ryan, 2009).

The Self Determination Theory has a sub-theory called the Organismic Integration Theory (Deci and Ryan, 1985). OIT has the concept of identification regulation (IR), where a person consciously accepts the value of an activity and self-endorses it, and thus by choice performs it (M. Ryan and L. Deci, 2000; Ryan and Deci, 2020). Hence this behaviour is a more self-determined and regulated form of motivation. For example, a student studies a concept for the value it provides for her future career and not because it is interesting. OIT also has integrated regulation, where the person accepts the value of doing the activity and finds it in agreement with their values (M. Ryan and L. Deci, 2000; Ryan and Deci, 2020). Integrated regulation (IR) is a relatively less controlled form of self-regulation. In IR activity is performed for acceptance of its importance (M. Ryan and L. Deci, 2000; Ryan and Deci, 2020). Some human behaviours can start as integrated regulation (M. Ryan and L. Deci, 2000). For example, a person might take up a task as he/she identifies its value. It might happen that if this task is not taken under pressure, then the person might start to find it interesting in an intrinsic way in the long run. If the student tries, then it could result in a shift in the orientation of the motivation from extrinsic to intrinsic (M. Ryan and L. Deci, 2000).

The authors (Kusurkar, Croiset and Ten Cate, 2011) state that all students in a classroom might not be interested to learn a particular topic or they might find certain topics uninteresting. In such cases, the teachers should explain why it is important to learn the topic. should provide a rationale as to why the topics or activities are important to study. For example: If a student is not interested in learning a *particular topic* from Biochemistry, then the teacher should explain to the students why this topic is important in medical diagnosis as they would encounter many patients with this condition, and if they missed the diagnosis then what would be the implications. Also, the tutor may ask if the students have any family members with that condition and make it relevant to them (Kusurkar, Croiset and Ten Cate, 2011). After this, the students would choose to study the topic autonomously and not under the pressure of the tutor and become more self-determined and regulated in their learning approach thereby promoting intrinsic motivation (Kusurkar, Croiset and Ten Cate, 2011). Mastery or practice of

tasks is important to be engaged in the activities. Also, the larger purpose for which the learning activity or task is done is if it is deeply satisfying and personally challenging then it inspires the highest creativity and engagement in the task (Teresa M. Amabile, 1996; Pink, 2009). It is highly motivating and inspiring to people if the task that they are doing is impacting them, society, or company, or clients positively or has a far-reaching positive outcome on society at large (Hewlett, 2009; Pink, 2009).

In section 2.4, the important factors from the literature that promote ARC feelings among students are provided as a summary. In the subsequent sections, we see how optimal challenges and peer modeling help to promote the feeling of intrinsic motivation among students.

## 2.3 Peer modeling and intrinsic motivation

In learning, *modeling* is used to get knowledge, skills, and new behaviours (Rosenthal and Zimmerman, 1978; Bandura, 1986). Usually, in a traditional classroom, students learn from their tutors. But it has been observed that in day-to-day learning in class, children also learn from the learning behaviours of their classmates or friends having similar attributes like competence, age, and gender (Schunk, 1987; Ohtani *et al.*, 2013). Students not just learn but also get motivated for learning by observing their peers. This concept is called peer modeling (Ohtani *et al.*, 2013). Due to the above factors, peer modeling plays an important part in learning. Technically peer modeling is defined as *"cognitive, affective, and behavioural change that derives from observing models"* (Schunk, 1998; Ohtani *et al.*, 2013, p. 631). Dale H. Schunk (Schunk, 1987) states that a peer in peer modeling is a person who is like the observer in skills and knowledge. While a model is a person whose expressions, speech, and behaviour patterns are taken as signals for modeling by the observer, modeling is the changes in the behaviour of the observer after observing others' (Berger, 1977; Hartup, 1978; Field, 1981; Schunk, 1987).

Peer modeling is derived from the feeling of *self-efficacy*. *Self-efficacy* is an important human emotion where the person has belief in one strength and skills that are required to handle most situations (McQuiggan, Mott and Lester, 2008). Self–efficacy is important for achieving success in problem-solving. It determines how the student will react to failures, their persistence, efforts, and choices they make, and the success they will achieve in terms of solving any task (Bandura, 1995; Zimmerman, 2000; Schunk and Pajares, 2002). Students with high self-efficacy are motivated to solve any task and can control their actions and feelings. While students with low self-efficacy think that the tasks are too challenging which leads to anxiety and frustration (Bandura, 1986, 1997; R Lepper *et al.*, 1993; McQuiggan, Mott and Lester, 2008). It has been found that students with low motivation and self-belief in their

capabilities when exposed to successful peer models had a positive impact on their learning. Students usually compare themselves with other students or peers who they perceive as having similar skills to themselves. Self-efficacy of students increases if they see a similarly skilled peer succeeding at a task (Bandura, 1997; Zimmerman, 2000; McQuiggan, Mott and Lester, 2008). Thus, from the above-mentioned points, we can conclude that peer modeling can be used to motivate students by building a feeling of self-efficacy. Thus, the students' feeling of competency concerning any skill or task will increase. Peer modeling can be looked at as a *self-regulated learning* strategy where learners observe the behaviours and problem-solving strategies of their peers and self-modulate their learning accordingly (Schunk, 1998; Ohtani *et al.*, 2013). In self-regulated learning, students decide their course of action, set their learning goals, and track their progress and achievements at their own pace. As per Self-Determination Theory learners who self-regulate their learning experience have greater intrinsic motivations which help them to be persistent in their efforts for their learning (Ryan, Connell and Grolnick, 1992; Kim, Belland and Axelrod, 2018). Research has indicated that peer modeling is positively related to intrinsic motivation in the classroom (Ohtani *et al.*, 2013). Near-peer models help learners to identify their sub-goals in their learning tasks and problems. By observing what peer models can achieve on their own, the learners can identify the next steps in solving their problems (Muir, 2018).

### 2.3.1 Near peer model attributes and characteristics

In the previous section, we saw that for peer modeling the comparison is done with a similarly abled peer. A near-peer model is a person who is comparable to us in fundamental ways in terms of age, gender, ethnicity, culture, and past experiences (Muir, 2018). We feel closer to the person who is like us, and this can have a far more positive impact on our motivation level than with someone who is not like us but demonstrates higher success (Muir, 2018). The similarity is specifically important when students are not very sure about their performance capabilities or have self-doubts and are not familiar with the assigned tasks (Bandura, 1986; Schunk, 1987). To define this nearness with the peer models, researchers have defined certain peer model attributes mentioned in table 1 below.

| Attribute | Explanation |
|---|---|
| Age | Near-peer models should be similar in age. They can also be slightly younger as well. Observation of older peer models leads the learner to think about whether he/she is competent to perform the task successfully. In circumstances where learners don't know their capabilities, comparison with similar-aged peers can raise their self-efficacy (Schunk, 1987; Watson, 1993). |
| Gender | It is preferred that the peer model shall be of the same gender as the learner. |

| | |
|---|---|
| Background | It is preferred that the peer model have a similar professional, social and economic background as the learner. |
| Competency | Competence[3] means abilities or skills, and knowledge to solve a task. It is preferred that the skills of the peer models should be similar or a little bit lower than the learner's (Murphey and Murakami, 1998). |
| Nationality, culture | Peer models should have the same nationality and similar cultural background as the learner. |
| Demography | Peer models should have the same demography as the learner. |

Table 1 Peer model attributes

Also, researchers have recommended certain characteristics of near-peer models are important when implementing peer modeling for learning in classrooms: -

1. Number of peer models: Research suggests that multiple peer models are more effective in motivating learners than single peer models (Thelen *et al.*, 1979; Bandura, 1986; Schunk, 1987). Using multiple peer models increases the chances that the learner feels similar concerning competence to at least one of the models. When learners have doubts about their abilities and because of that, they may discard the success of a single peer model (Thelen *et al.*, 1979; Bandura, 1986; Schunk, 1987). Studying diverse peer models can increase the self-efficacy of students (Thelen *et al.*, 1979; Bandura, 1986; Schunk, 1987).

2. Comparison of mastery and coping models: Mastery models are those peer models whose performance on the task is perfect and without any faults. While coping models struggle at first, and demonstrate frustration and low confidence, they are persistent in their efforts and finally succeed at their tasks (Schunk, 1987). Coping models demonstrate how one can achieve success while being persistent in their efforts. It is observed that students gain more self-efficacy when they observe coping models than by watching mastery models (Schunk, 1987). Coping models are good for learners who have struggled and failed earlier in their tasks (Schunk, 1987).

In the next section, we look at examples of peer modeling with the usage of technology in real-world classroom settings.

### 2.3.2 Examples of peer modeling and use of computer-assisted technology

Earlier peer modeling was done through direct observations in the classroom by school-going children. In classroom school, kids observe and learn from their peers and tutors (Schunk, 1987). Pre-recorded videos about the learning experiences and motivation levels of peer models are also shown to students. In the early 1990s, Murphy (Murphey and Arao, 2001) and his colleagues experimented in the English language department at a Japanese University,

[3] https://dictionary.cambridge.org/dictionary/english/competence

where they made a recording of the experiences of Japanese students learning the English language. They recorded the experiences of students in an 8-minute video clip. This clip considered the following points (Murphey and Arao, 2001)

- English learning was fun for Japanese students and how they succeeded in learning English.
- It is fine to make mistakes while learning the English language.
- Making goals while learning a new foreign language is good for language learners.

When the Japanese students watched the student video clip, it reportedly increased their self-belief in their abilities to learn the English language (Murphey and Arao, 2001). They realized that it was fine to make mistakes while learning the English language and they could enjoy learning a new language (Murphey and Arao, 2001). In a similar experiment made by researchers (Kichiji, 1997; Murphey and Arao, 2001) videos of Japanese businesswomen who returned to university were shown to the students. By watching these videos men became aware that it was fine for women to complete their education and women became aware that it is possible to find and have alternative career paths (Kichiji, 1997; Murphey and Arao, 2001).

In recent years, new technologies have been used to incorporate peer modeling. Peer modeling has been used for language learning (Ashton-Hay and Brookes, 2011; Kovačević *et al.*, 2013). At the Queensland University of Technology, English language teachers used a learning management system where podcasts, photos, and story transcripts of students learning English were hosted. The podcasts were made to record the English language learning strategies and experiences of students. These experiences were shared with other students via the homepage of the learning management systems. The main aim of this was to provide positive and unique peer models for students learning languages as well as innovative and sustainable learning resources (Ashton-Hay and Brookes, 2011; Muir, 2018). It has been found that watching regular videos of peer models for language learning has positively impacted the learners in their learning (Murphey and Kenny, 1998; Murphey and Woo, 1998; Muir, 2018).

Teachers asked students to keep “action logs” about their homework. This log contains the strategies they used for preparation, the challenges they faced, and how they were overcome (Murphey, 1993, 1996; Muir, 2018). In the classroom, students thought as good examples were told to share their logs with other students as a learning experience and to give inspiration (Murphey, 1993, 1996; Muir, 2018). Apart from using recorded videos, educationalists suggest the use of implicit online tools like discussion forums, chat tools like Skype, etc. to discuss the learning experiences with their peer models (Muir, 2018).

### 2.3.3 Peer modeling and optimal challenges

"Optimal challenge refers to the balance between the challenge level of an activity and the skill level of an individual involved in the activity" (Soltani *et al.*, 2011, p. 1). Studies have shown that optimal challenges have been a facilitator of intrinsic motivation among students (Soltani *et al.*, 2011). Tasks that are very novel and challenging to students create anxiety in students and diminish intrinsic motivation (Di Domenico and Ryan, 2017). While tasks that are too easy or routine cause boredom in students and reduce intrinsic motivation (Di Domenico and Ryan, 2017). Competence is promoted when the learning environment provides optimally challenging tasks, proper and clear learning goals (structure and guidance), and informative feedback to the students (Reeve, 2014; Legault, 2017). Hence competence is an important element for the psychological well-being of humans for intrinsic motivation and satisfaction(Deci and Ryan, 2008). Belland, Kim, and Hannafin (Belland, Kim and Hannafin, 2013) suggest that peer modeling can be incorporated into scaffolding to create a perception of optimally challenging tasks. Peer modeling can be used to showcase how students of similar abilities were successful in solving the same task despite the challenges (Bandura, 1997; Schunk, 2003; Moos and Azevedo, 2009; Belland, Kim and Hannafin, 2013). Belland, Kim, and Hannafin (Belland, Kim and Hannafin, 2013) further suggested that narratives of peer students who solved the task successfully can be used in scaffolding strategies to promote the feeling of optimal challenge. For that, they further suggested that these narratives can be recorded in videos or written text and these narratives can have the following attributes (Bandura, 1997; Belland, Kim and Hannafin, 2013):-

- The narratives should suggest the skills and knowledge level of the peer.
- The action or strategies and cognitive abilities required to solve the task.
- The peer struggled to solve the problem.
- The peer was persistent and put effort to solve the problem.
- The peer finally succeeded in their task.

When the students see that their similarly abled peers were able to solve the challenge, they perceive the task as optimally challenging, which raises their feeling of competency among them and promotes intrinsic motivation among them (Belland, Kim and Hannafin, 2013). The second strategy for creating a perception of the optimal challenge is to add persuasion tactics in scaffolding to convey the message that they can successfully solve the task. Persuading students that they can solve the task is the first step to creating a perception of optimally challenging tasks (Belland, Glazewski and Richardson, 2008). Exposure to peer models can bring an immediate increase in levels of motivation and excitement and risk-taking emotions in students (Muir, 2018).

## 2.4 Summary of intrinsic motivation related factors

This sub-section shows the summary of important factors that promote or demote intrinsic motivation among students from the literature review conducted in the previous sections and subsections. Figure 6 gives the summary to the end-user in a condensed format about the intrinsic motivation-building factors (IMBF) that are discussed in sections 2.1 to 2.3 of the literature review.

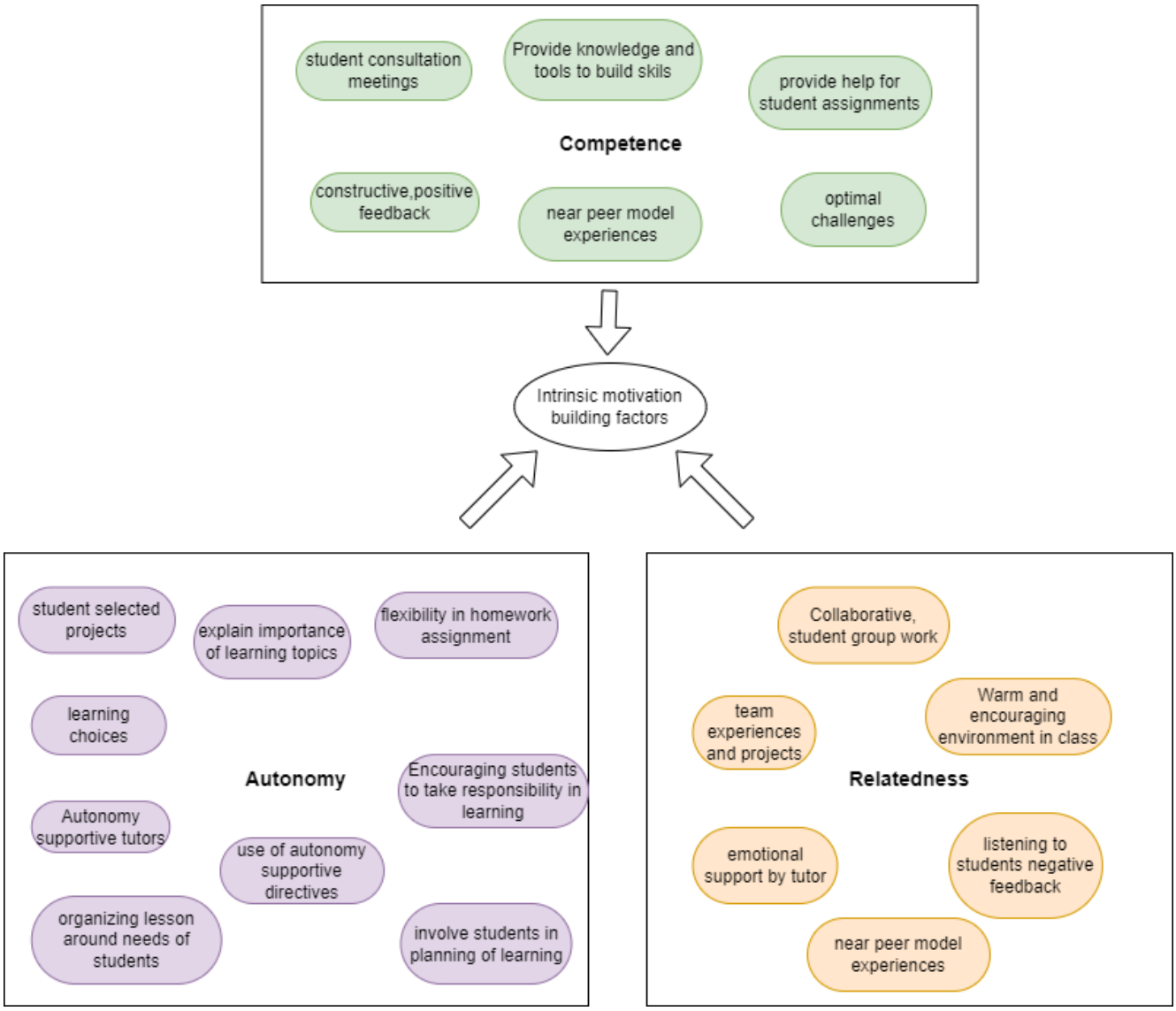



Figure 6 Intrinsic motivation building factors from literature.

Table 2 below give a brief description of each of the intrinsic motivation building factors supporting the ACR needs described above in the figure 6.

| Factors supporting autonomy | Factors supporting competency | Factors supporting relatedness |
|---|---|---|
| 1. Autonomy can be given to students by replacing mandatory assignments with student-selected/designed projects. Students could also decide which homework they could complete from a set of homework assignments (Trenshaw *et al.*, 2016). | 1. Student consultation meetings to discuss student problems and provide help or guidance for their assignments help to build competency among students (Trenshaw *et al.*, 2016). | 1. Relatedness is often described in the context of collaborative or team experiences. Activities like collaborative and team projects, discussions, and periodic consultation/counseling meetings promote the feeling of relatedness among students (Trenshaw *et al.*, 2016). |
| 2. Autonomy support can be provided to students by giving them choices for their learning (Ng, Liu and Wang, 2016). These choices can be determining the sequence of topics in the course and volunteering options for presentations. Being involved in course planning activities also helps students feel closely connected (feeling of relatedness) to the module (Kusurkar, Croiset and Ten Cate, 2011). | 2. Competence is built by providing necessary knowledge and skills, tools, and immediate constructive feedback to students concerning their learning tasks (Niemiec and Ryan, 2009). | 2. Supporting the emotional needs of students by creating a warm atmosphere where students could ask doubts without fear promotes the feeling of relatedness among students concerning the teacher and other students (Kusurkar, Croiset and Ten Cate, 2011). |
| 3. It was found that students who were taught by autonomous tutors had more intrinsic motivation, competency, and self-esteem (Grolnick, Ryan and Deci, 1991; Niemiec and Ryan, 2009). | 3. Constructive feedback with knowledge about how to accomplish the task at hand further enhances students' feeling of competency (Niemiec and Ryan, 2009). | 3. Listening patiently to students' negative comments and reactions without being judgmental, encouraging active participation of students in group activities, and identifying and nurturing the needs of students promote the feeling of relatedness (Kusurkar, Croiset and Ten Cate, 2011). |
| 4. Organizing the lesson around the needs of the students (Kusurkar, Croiset and Ten Cate, 2011) helps build a state of self-determination among students and students then study more autonomously rather than under pressure. | 4. Optimally challenging tasks that are not very simple or very difficult provide a sense of competency among students (M. Ryan and L. Deci, 2000; Niemiec and Ryan, 2009). Furthermore, it is found that interesting, enjoyable, and curiosity-driven tasks build intrinsic motivation among students (Di Domenico and Ryan, 2017). | 4. By listening to or reading similar peer students' experiences for example making mistakes in learning or taking alternative career paths, students can feel connected to their student peer models and get motivated (Kichiji, 1997; Murphey and Arao, 2001). |
| 5. Telling students, the importance of learning a topic helps them to understand the value of the topic for their career and they decide to study it autonomously by thus shifting to a state of self-determination (Kusurkar, Croiset and Ten Cate, 2011). | 5. Providing guidance and consultation in student activities/homework builds competency among students (Trenshaw *et al.*, 2016). | |

| | | |
|---|---|---|
| 6. Phrasing sentences using autonomy-supportive words (may, could) gives choices to students to decide for themselves rather than binding them to do the activities (Kusurkar, Croiset and Ten Cate, 2011). The teachers could use something like "*You could do this assignment because it will help you….*" Instead of "*You must do this assignment….*". The use of control directives, for example, *must, should,* etc. undermines intrinsic motivation (Kusurkar, Croiset and Ten Cate, 2011). Phrasing sentences without using controlling words gives choices to students and they can decide for themselves rather than binding them to do the activities (Kusurkar, Croiset and Ten Cate, 2011).<br>7. Students could also be given the flexibility to decide which homework they could complete from a set of homework assignments to promote a feeling of autonomy in them (Trenshaw et al., 2016). | 6. Peer modeling learning experiences of similar students build the feeling of self-efficacy among students concerning the learning tasks and activities (McQuiggan, Mott and Lester, 2008). The feeling of self-efficacy is the trust in one's overall competency across a wide range of activities (Rama and Sarada, 2017). | |
| 8. Students could be encouraged to take more responsibility for their learning. Taking more responsibility for their learning positively affects student motivation levels (Willis *et al.*, 2002). | | |
| 9. Students can be given autonomy by giving them the freedom to plan their assignments (Kusurkar, Croiset and Ten Cate, 2011). | | |

Table 2 : Intrinsic motivation building factors (IMBF)

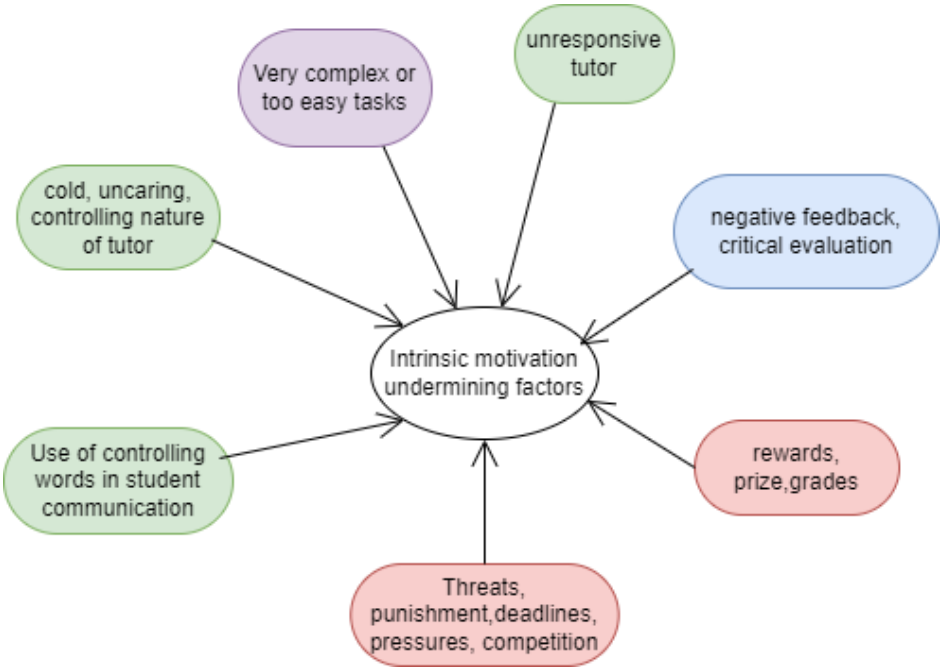



Figure 7 Intrinsic motivation undermining factors from literature.

Figure 7 summarizes the key points that impact the intrinsic motivation of students in a negative manner.

1. In a learning environment where tutors were cold and uncaring towards the students and who did not respond to the initiations of the students while learning activity or during a task: such students were found to have low levels of intrinsic motivation (Anderson, Manoogian and Reznick, 1976; Ryan and Grolnick, 1986).
2. Autonomy feeling in students is undermined when they are controlled by either grades, rewards, or punishments (Ryan and Deci, 2020).
3. Intrinsic motivation is greatly reduced in people when there are threats, deadlines, pressure, competition, and exams because it is thought of or perceived as controllers of their behaviour (M. Ryan and L. Deci, 2000).
4. Students who are controlled also show less intrinsic motivation and exploratory behaviours (M. Ryan and L. Deci, 2000).
5. When extrinsic rewards are offered to students they don't complete or try another task unless another reward is offered (Deci *et al.*, 1991; Harpine, 2008).
6. Negative feedback diminishes intrinsic motivation (Deci, 1975).
7. Tasks that are very novel and challenging to students create anxiety in students and diminish intrinsic motivation (Di Domenico and Ryan, 2017). While tasks that are too easy or routine cause boredom in students and reduce intrinsic motivation (Di Domenico and Ryan, 2017).

## 2.5 Rise of chatbots in education

Since the 1980's conversational agents like Intelligent Tutoring Systems are being used to automate learning instructions for students (Garcia Brustenga, Fuertes Alpiste and Molas Castells, 2018). But they are tied to a specific knowledge domain (Garcia Brustenga, Fuertes Alpiste and Molas Castells, 2018).

While chatbots can hold intelligent human-like conversations like humans, analyze the meaning and emotions of what humans are saying, and based on that propose different responses and solutions to the end-users (Garcia Brustenga, Fuertes Alpiste and Molas Castells, 2018). Chatbots are considered tools for interpersonal communication between people and help to promote learning and provide different types of information and knowledge. Additionally, they provide easy-to-use conversational interfaces and interactive methods for effective communication (Yamada *et al.*, 2016; Muniasamy and Alasiry, 2020; Poncette *et al.*, 2020; Hwang and Chang, 2021). Chatbots or virtual assistants like Apple's Siri, and Google's Cortana agents are being used in our daily lives to set calendar events, play music, and open different apps (Cunningham-Nelson *et al.*, 2019). In the scientific literature terms like chatbots, conversational AI agents, and conversational agents (CAs) are being used interchangeably. Chatbots can be with or without Artificial Intelligence (AI) (Tudor Car *et al.*, 2020; Chew, 2022). Traditional chatbots are rule-based and perform actions based on the occurrence of certain domain-specific keywords in user requests and utterances (Tudor Car *et al.*, 2020; Chew, 2022). While advanced chatbots use AI techniques that refer to a machine's imitation of human intelligence for task/problem solving, and decision making mostly by making use of machine learning algorithms (Chew, Ang and Lau, 2021; Chew, 2022). Due to advancements in AI techniques like natural language processing, machine learning, etc., chatbots are becoming increasingly intelligent. Due to this, their usage in the education field is on the rise (Følstad and Brandtzæg, 2017; Hwang and Chang, 2021). Natural language processing capabilities allow a chatbot to interpret the user's intent and also respond in human-like language (Tebenkov and Prokhorov, 2021). Such techniques use supervised and unsupervised learning. In supervised learning, the computer is taught to convert one particular input into the desired output so that newer examples of the same type use the same output function to get the same output result (Tebenkov and Prokhorov, 2021). Unsupervised learning uses techniques to find new patterns in the data. The output function is directly assigned to data to find new patterns (Tebenkov and Prokhorov, 2021). The technical discussion concerning these algorithms is beyond the scope of the literature review.

Nowadays students are internet and mobile savvy by using mobile and social media technologies like Facebook, WhatsApp, etc. In current classrooms, the number of students is increasing due to the *MOOC* (Massive Open Online Course) format of courses (Winquist and

Carlson, 2014; Brinton *et al.*, 2015). It is therefore not physically and logistically possible for tutors to give personalized attention and support to each one of them thereby reducing student engagement (Winquist and Carlson, 2014; Brinton *et al.*, 2015). Chatbots can give students customized support and increase student engagement thereby freeing the administrative time of tutors which they can spend on developing coursework and performing research (Cunningham-Nelson *et al.*, 2019). There are some advantages of having chatbots. They can reduce operation and customer service costs significantly by replacing human intervention with routine jobs (Winquist and Carlson, 2014). Secondly, they can provide twenty-four-by-seven customer support and increase customer satisfaction by providing customized experiences based on the location and preferences of end-users (Winquist and Carlson, 2014; Howlett, 2017). In the education field, the use of chatbots has shown a positive impact on student learning outcomes and satisfaction (Winquist and Carlson, 2014).

Chatbots have been used for many different tasks and scenarios in educational settings for some benefits. For example, in the fall of 2014, the computer science department of Georgia Tech University received thousands of user messages for one of their online courses. The teachers and staff were overwhelmed by the messages. To ease off their workload a new chatbot assistant named Jill Watson was introduced in the class (Goel, 2020). Jill answered hundreds of routine questions and FAQs asked by students on the forums. Jill made use of a digital library containing questions and answers from students from previous semesters. Jill interpreted the new question and based on it classified the question into a new category and retrieved an existing answer from the existing digital library and gave the response back to the students (Goel, 2020). Jill Watson has now evolved into a much more advanced chatbot that can answer any question related to the class syllabus and now uses a novel ontology of class syllabus data to retrieve potential answers for user questions (Goel, 2020). As a result of this chatbot, students were more engaged in their learning, and at the same time, teachers could look into more strategic and complex doubts of students (Winquist and Carlson, 2014; Goel, 2020). Many digital learning apps are integrating chatbots or conversational agents in them for example Duolingo bot for language learning, and health (mental and physical) education. Learning with the help of a conversational agent is called conversational learning (Kowald and Bruns, 2020).

Chatbots are also used as digital tutors to teach concepts to students. One such example is Kim the digital tutor that teaches AI and IT concepts to students with little or no knowledge of the above topics (Kowald and Bruns, 2020). Kim does not answer the user's FAQs but rather holds conversations with users taking the lead at the start and then answering students' questions along the way (Kowald and Bruns, 2020). It converses using short chunks of interesting answers and uses emojis, images, rich media, and video links. to make answers/responses interesting and rich to students. It also makes conversations easy by giving options for user inputs like buttons, and menus (Kowald and Bruns, 2020). Chatbot Kim makes conversations interesting by adding rich media but also asks for the user's input while going ahead with the next conversation chunk. It thus gives a more human touch to the conversations (Kowald and Bruns, 2020). Please refer to Figure 8 below to see a snapshot of the chatbot Kim with rich video and text.

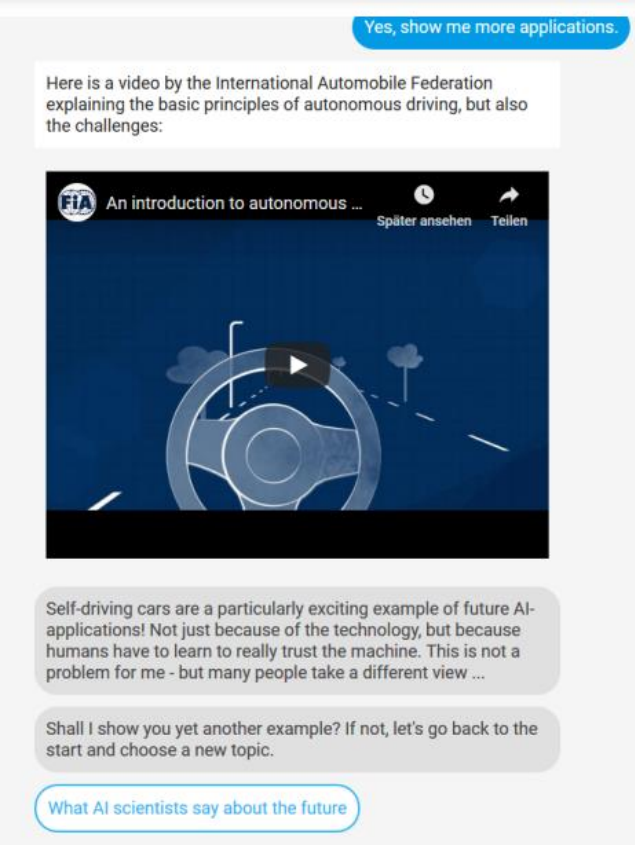



Figure 8 Chatbot with video and rich media (Kowald and Bruns, 2020)

### 2.5.1 Features of chatbots supporting ARC needs.

It is observed from the literature review that chatbots show features or traits that support the ARC needs of the students. ARC or autonomy, relatedness, and competency emotions are closely related to intrinsic motivation among humans (M. Ryan and L. Deci, 2000).

Autonomy is the sense of freedom in students to take charge of their learning needs and proceed as per their choice and speed (Trenshaw *et al.*, 2016). This trait of autonomy can be seen in some examples of chatbots from the literature review. For example: -

1. Chatbots allow students to control their learning at their own pace by interacting with them synchronously (Usher *et al.*, 2012) (i.e., support students' need for autonomy). In chatbot-based learning, the chatbot can be customized with course content, and prompts and choices/menus can also be pre-set. In chatbot-based learning, students can choose their learning paths, do learning at their speed, pause and resume tasks from where they left off, ask questions, see immediate results on screen, and track their progress (Pereira, 2016; Papaioannou, Dondrup and Lemon, 2018; Kowald and Bruns, 2020). Dawebot (Pereira, 2016) is a chatbot that delivers conversational multiple-choice quizzes to students. Students can practice these questions whenever they want. The bots show different choices to students for example: allowing them to select and take any quiz they prefer at any time; setting an appointment with the tutor; explains right and wrong answers. It also provides progress of the tests done so far. All the interactions of the quiz are stored in the database. Students who used Dawebot felt that the chatbot allowed them to practice the quizzes at their own pace and helped them, foster interest and understanding of the subject, and kept them engaged in learning (Pereira, 2016).
2. Chatbots are used to build motivation by sending inspirational/educational messages at specific time intervals to end-users (Gaag, 2013). FitBot (Gaag, 2013) reminds users of their weekly exercise plans/routines and educates/motivates users by sending them inspirational and educational messages. Users can also set their workout goals and reminders as per their choice. Following is an example of one message: "A lack of physical activity increases the risk of dying of cancer 45 percent for men and 28 percent for women" (Gaag, 2013). Please refer to Figure 9 for the image of the Fitbot with workout reminder service. Moreover, chatbots are also being used by students to ask for schedules for upcoming exams and practice assignments (Rodriguez, Piccoli and Bartosiak, 2019). Such chatbots help students with reminders about practice exams and help to reduce academic procrastination among students so that they become more active and engaged in learning. Such chatbots use triggers, signals, or reminders (in form of mail or buttons on the screen or a message) to remind students of upcoming important events so that students become alert and more active and follow the deadlines. Such digital reminders are also called nudges (Rodriguez, Piccoli and Bartosiak, 2019). Rather than forcing end users to follow certain habits or deadlines, these chatbots help users to take control of their learning or workout and become self-determined in their behaviour.

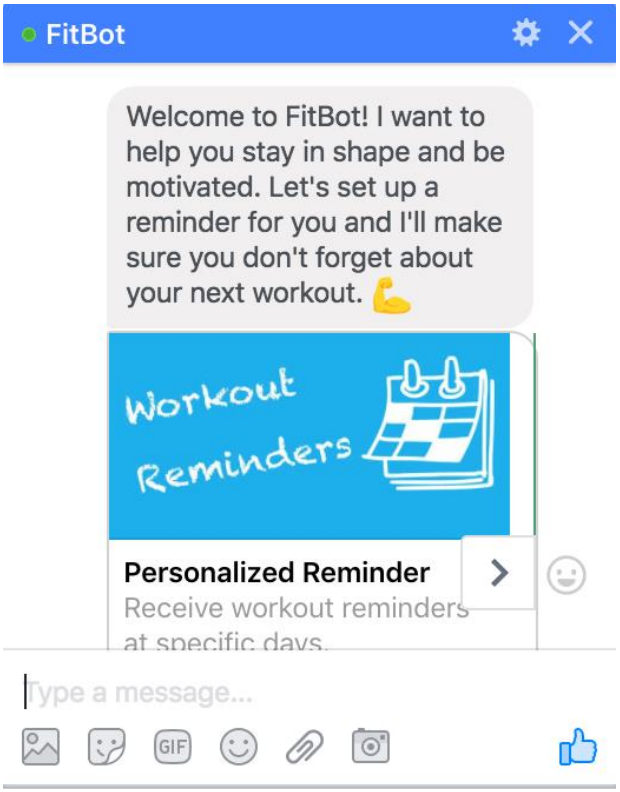



Figure 9 Fitbot with workout reminder service (Gaag, 2013)

3. Chatbots have the features of customization of responses to users based on user settings/preferences (Garcia Brustenga, Fuertes Alpiste and Molas Castells, 2018). They can be easily tailored to use autonomy-supportive directives such as “could”, “may”, and ”can” to build the feeling of autonomy in students.
4. Similarly, to building autonomy in class chatbots could also provide some settings so that chatbots could allow students to set and adjust their own learning goals and home assignments based on their workload and deadline.

Competency in students is the feeling that they can perform a task or do well in their educational tasks (Trenshaw *et al.*, 2016). Competence can be built among students by providing the necessary tools to build skills and giving them immediate constructive positive feedback (Niemiec and Ryan, 2009). Now chatbot mediated learning (CML) is an increasing trend where web-based chatbots are used for synchronous learning by students to increase learning productivity (Winquist and Carlson, 2014). We see some examples of CML where chatbots are used to build skills among students: -

1. Chatbots are used for delivering microlearning instructions to students (Yin *et al.*, 2021). Microlearning is small duration-based learning tasks that can be completed in a short time of 10 minutes and can be done via multiple devices (Shail, 2019; Yin *et al.*, 2021). Chatbot-based microlearning (CBML) follows the Self-Determination theory for intrinsic motivation. Such chatbots use rich media like text, images, and videos which makes

learning interesting and fun (Shail, 2019; Yin *et al.*, 2021). According to (Shail, 2019) microlearning concept is an effective one as the learning content is given to students in a shorter duration to reduce information overload. The retention of knowledge given in short content and duration is also high among students (Giurgiu, 2017; Yin *et al.*, 2021). These chatbots provide immediate constructive positive feedback to build competency among students and provide a chance for self-evaluation and the construction of knowledge in students (Burgers *et al.*, 2015; Yin *et al.*, 2021). These chatbots provide a chance for self-regulated learning to students by giving them the freedom to choose self-evaluation and access and preparing for optional learning materials (Patall, Cooper and Robinson, 2008; Yin *et al.*, 2021). Thus, these chatbots provide a platform for building competency by giving them a platform for skill-building and by imparting autonomy to students so that they make their own choices for their learning and thus motivate students intrinsically (Riel, 2021; Yin *et al.*, 2021).

2. Chatbots can hold intelligent conversations with end-users and that is why they are especially being created and used for language learning by students. They are especially being used for taking English language lessons (Fryer, 2006). Duolingo bots have special profiles or avatars, and these bots get smarter with practice. These bots have a personalized learning environment where users can track their language learning progress reports and get instant rewards after the completion of learning levels (Duolingo, no date). Language learning bots also provide hints/help to students if they are stuck in their exercises (Sawyers, 2019).
3. Chatbots can send immediate feedback to students upon their task completion. The chatbot can send positive and motivational messages to cheer students both for correct and incorrect answers and try to boost their motivation (Pereira, 2016). The chatbots can detect if students are inactive for some time in a task and whether they need help or hints to solve it. They can also provide links to additional materials if students are interested to increase their existing knowledge level of a particular topic (Pereira, 2016). Dawebot is a multiple-choice question quiz bot that allows users to take a particular quiz at any time. It also gives immediate feedback when students solve a question and provide an explanation if a particular answer is right or wrong (Pereira and Juanan, 2016). This chatbot application makes mind maps of the current knowledge level of a student which is used by tutors for assessment of the progress of the student in each topic. Such chatbots can be used by students to assess their knowledge of a particular topic by taking practice quizzes before the actual examinations. Another chatbot named SQL quiz bot provides immediate cumulative feedback to students on the strength and weaknesses of each student in every topic along with areas of improvement (Vijayakumar, Höhn and Schommer, 2019).

Chatbots can also be used to generate curiosity among students by asking them challenging and interesting questions (Winquist and Carlson, 2014).

Students feel related to the teacher when their ideas are welcomed in the classroom and they feel liked and respected by the teacher and when they have a warm and friendly atmosphere in the class and can ask their doubts and questions without fear (Niemiec and Ryan, 2009; Kusurkar, Croiset and Ten Cate, 2011). Relatedness is also promoted by listening patiently to students without judging them; encouraging them to actively participate in group work; by identifying and nurturing the needs of the students (Kusurkar, Croiset and Ten Cate, 2011). Following are examples of chatbots/features showing evidence of relatedness: -

1. Differ chatbots create communities of students facing similar problems in their assignments and projects (Differ, 2017; Garcia Brustenga, Fuertes Alpiste and Molas Castells, 2018). Differ chatbots suggest students discuss their problems with mentors and prompt students with similar doubts and problems to join a group discussion. It allows students to ask any doubts and queries by creating a warm and friendly environment. A chatbot can answer the same query multiple times without getting tired and judging the end user (Fei and Petrina, 2013). It thus removes any fear from the mind of the end-user.
2. Jolt.ai is a chatbot that connects users with similar exercise goals to create communities of similar users so that they can support each other emotionally to fulfill their exercise goals and become fit (Jolt, no date; Riggs-Zeigen, 2018).
3. Currently, chatbots can detect the different emotional states of students such as boredom, anxiety, fear, and excitement concerning their learning (Garcia Brustenga, Fuertes Alpiste and Molas Castells, 2018). They use this information to provide personalized emotional support to students(Winquist and Carlson, 2014).
4. Emotionally intelligent chatbots like Wysa can detect mood swings among patients and proactively provide them with emotional support to make patients feel better. Over time they learn more about their patients through interaction and provide much better emotional assistance (Singh, 2017; Wysa, 2022).

Thus, the examples from the literature review suggest that certain chatbot features promote the three main emotional needs of students i.e., autonomy, relatedness, and competency. Hence *chatbot mediated learning* (CML) or learning delivered by chatbots is found to promote intrinsic motivation among students in educational settings. An experiment (Yin *et al.*, 2021) was done on 99 students where one group was taught in a traditional classroom, and one was taught by a microlearning chatbot. The topic for the chatbot content was a *conversion for numerical analysis* meant for first-year university students of *Computer Science*. Figure 10 below describes the typical flowchart of such a system. Most of the lessons in microlearning contain video explanations which are followed by exercises (Yin *et al.*, 2021). Every lesson

takes 10 mins approximately. A pre-interaction quiz was taken by the students to assess their initial topic mastery level and a post-lesson quiz was conducted to know about the mastery level to assess their knowledge post-lesson (Yin *et al.*, 2021).

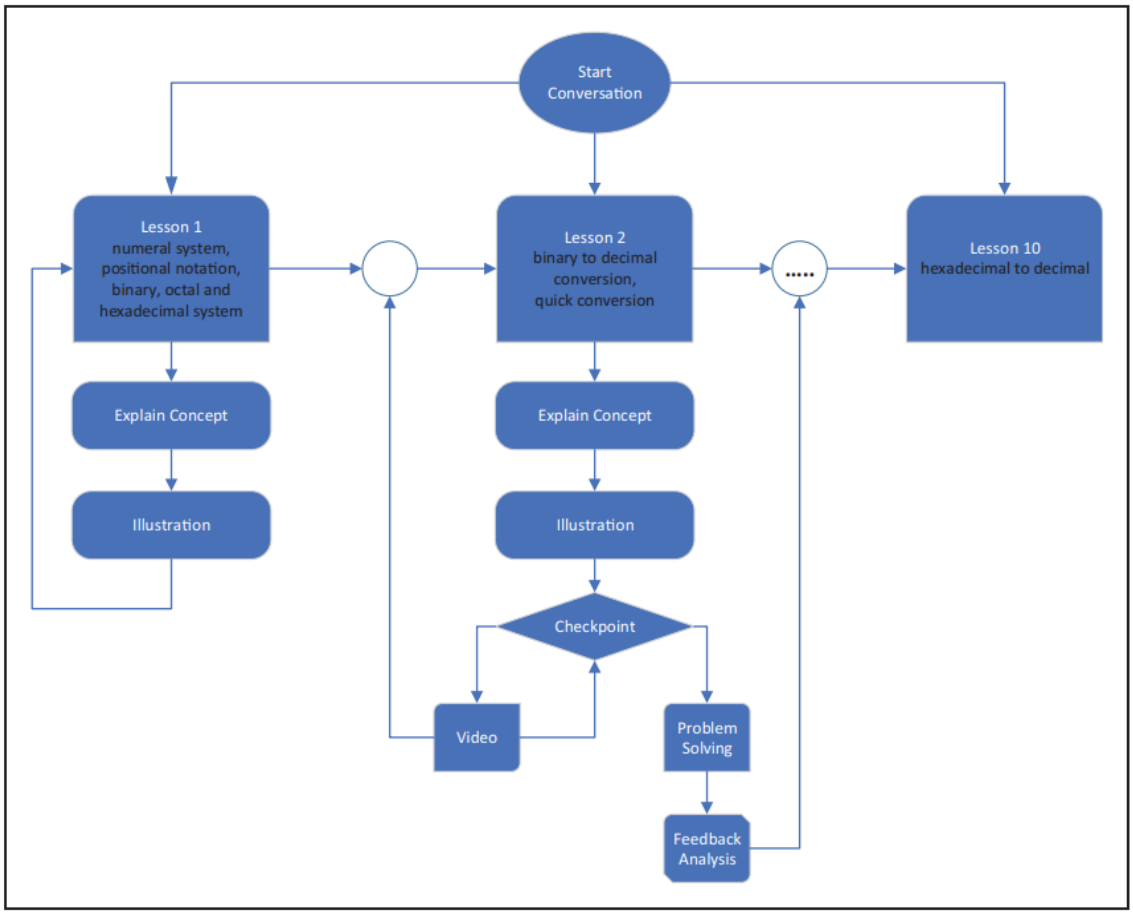



Figure 10 Flowchart of a chatbot microlearning system (Yin et al., 2021)

It was found that students in the chatbot-based learning environments were quite confident and competent to interact and learn with the chatbot and they did not feel the need for face-to-face learning (Yin *et al.*, 2021). Both groups achieved comparable performance on the same topic, but the chatbot group students displayed more intrinsic motivation than the students in a traditional learning group. Intrinsic motivation is contributed by perceived choice and value (Yin *et al.*, 2021). The main factors contributing to the intrinsic motivation were that the students could do the learning at their speed, received immediate feedback, and could repeat their learning whenever they want (Yin *et al.*, 2021). The students felt that the interaction with the chatbot was valuable as they could interact freely without tension as compared to a traditional classroom (Yin *et al.*, 2021).

### 2.5.2 Comparison between web interfaces and chatbots

We have seen in section 2.1.2 that flipped classroom (FC) students face motivational challenges from the literature review. Students must prepare a lot before coming to class. They must read preparation materials and take pre-class quizzes (Triantafyllou, Timcenko and Kofoed, 2015). The materials are usually hosted on LMS interfaces like Moodle. Such LMS has a web interface for example Moodle. Its interface works for both mobile and desktop applications (Guerrero *et al.*, 2009). If a website or web interface has too many visual elements and information it puts a load on the visual processing of the users (Harper, Michailidou and Stevens, 2009; Nguyen, Sidorova and Torres, 2022). To perform a task or select some information from a website the user has to himself browse through the various links and menus and then access it (Nguyen, Sidorova and Torres, 2022). On the other hand, chatbots only show the information that is requested by the users. When the user requests any information from the chatbot, then the chatbot itself parses the request, understands the intent of the user, and presents the information to the end user (Nguyen, Sidorova and Torres, 2022). The interaction with a chatbot is natural and human-like and more easy-going as compared to a website. There is less information load on the end-users while using a chatbot than with a website (Nguyen, Sidorova and Torres, 2022). Due to their intrinsic motivation-building, chatbots can be ideal candidates to further investigate their significance and impact on flipped classroom preparation and intrinsic motivation. In the next section, we look at the current chatbot examples that are being used in the flipped classroom for learning.

### 2.5.3 Chatbots used in flipped classroom.

There is growing evidence from the literature review that chatbots are being used in flipped classroom scenarios to deliver learning and build motivation. Thus, we have seen from the examples of the literature review that chatbots are mostly used for delivering quizzes, answering users' questions about topics and preparation, setting learning goals, delivery of use cases, and as virtual assistants in an FC context. Figure 11 below gives the different usage of chatbots in the Flipped Classroom context found in the literature review.

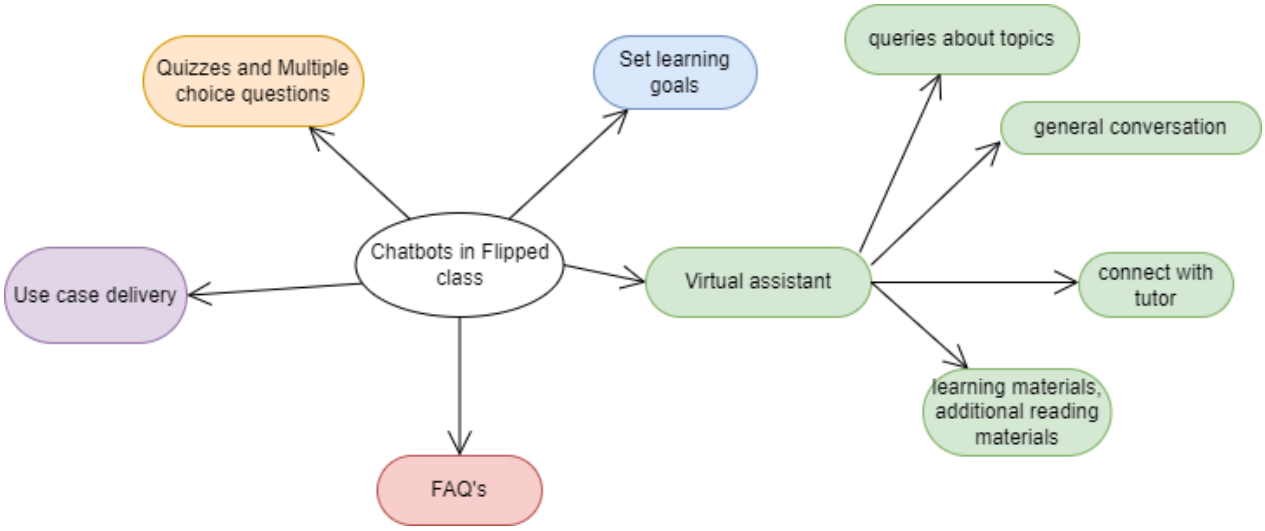



Figure 11 Various usage of chatbots in Flipped Class (FC) from the literature review.

The examples mentioned in Figure 11 are discussed in detail below.

1. A quiz chatbot (Hew *et al.*, 2021) has been developed in the LMS Moodle where pre-class quizzes are delivered to students. Students can take these quizzes before the actual class via the Moodle interface. After solving the quiz, the students get immediate feedback with an explanation about the right or wrong answer. To keep the mood light among the students, the quiz bot asks students whether they found the quiz useful. If the student's answer was positive, then the chatbot would thank the student for their answer (Hew *et al.*, 2021). The students found the chatbot useful for their learning and very easy to use. Figure *12* shows the embedded Moodle chatbot delivering quizzes to students in the flipped classroom.

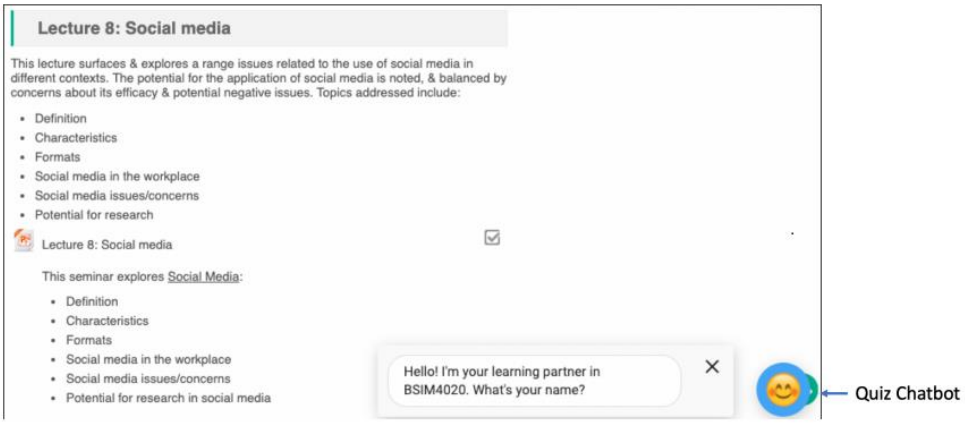



Figure 12 Moodle-based quiz chatbot in a flipped class *(Hew* et al.*, 2021)*

2. Another area in which a chatbot is used in an FC setting is goal setting. A goal-setting chatbot (Hew *et al.*, 2021), named learning buddy is used in the classroom so that students take charge of their learning and set appropriate goals before coming to the class. Students

were told to interact with the learning buddy. The students after accessing the chatbot are asked about what they wanted to gain the most from the lesson.

3.
4.
5.
6. Figure *13* below shows the learning goal chatbot and the options that it provides for goal setting in an FC. With the question, students are presented with three options that describe different learning goals in the upcoming flipped lesson. Depending on the selected response of the student appropriate learning instructions are presented. The main goal is to help students with low self-regulation to take charge of their learning, provide them with appropriate tips, and boost their motivation. This helps such students plan their learning without getting overwhelmed or lost in the learning process (Hew *et al.*, 2021). This chatbot helps students to set their personal learning goals at the start of the flipped lesson so that their learning is more self-regulated (Hew *et al.*, 2021). This chatbot was reviewed with university students in Hongkong. Some students found that the chatbot motivated them to set their learning goals; while other students liked that the chatbot provided them with personalized recommendations about their goals (Hew *et al.*, 2021).

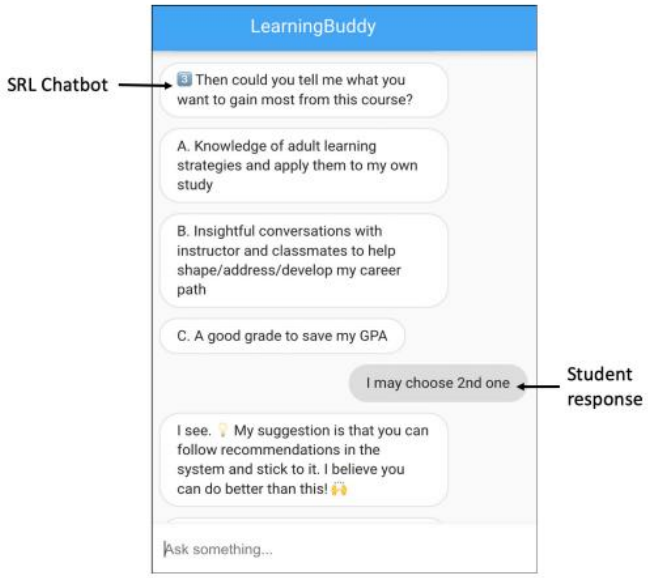



Figure 13: Chatbot for student goals in flipped class *(Hew* et al.*, 2021)*

7. Chatbots are also being used in the different stages of learning at the university level in flipped classrooms. One such example is the master's level course "Engaging Adult Learners" at the University of Hong Kong (Huang, Hew and Gonda, 2019). Three chatbots have been developed to support three levels of learning (Huang, 2019). The first bot is an MCQ (Multiple Choice Questions) bot that delivers quizzes based on the video lectures taken by the students. The MCQ bot gives two chances to the user if the answer is incorrect for a particular question. If the second attempt is incorrect, then it provides a detailed

explanation of the correct answer. This bot is a good choice for students to test their knowledge about their understanding before they move on to a graded quiz. The students then apply the concepts learned in the first stage (video lectures and quizzes) to a case study that is delivered by the case study bot. The chatbot asks close-ended questions about a narrow topic to get mostly yes / no answers from the students. This helps to get students' attention to a particular topic and to let them think about it. The questions are asked in a sequence to the students. For example: *What is the first step to solving this question*? OR *do you think this step is right*? The third chatbot is the dictionary chatbot that answers the FAQs related to terms and concepts of a particular topic. These three chatbots were tested with actual students in the classroom. Students had mixed feelings about these chatbots. Some students felt the attraction to chatbots and felt that they reduced their isolation while learning in Flipped Class (FC). While other students still felt that they interacted with a machine and not with a human tutor and felt it difficult to treat the chatbot as a human being (Huang, 2019). Because of this feeling, some students felt uncomfortable using the chatbots for a longer time. But the overall response was positive. It was found that there was an increased collaboration between chatbots and students, and the learning outcomes could be achieved much easier with the help of chatbots in FC (Huang, Hew and Gonda, 2019).

8. Another type of chatbot called a virtual teaching assistant is also being introduced in the flipped classroom (Tangkittipon *et al.*, 2020). This chatbot is introduced to improve the student's engagement in the learning topics and objects and to motivate them to prepare before class. The features of the chatbot include twenty-four-by-seven support, answering students' FAQs[4], holding general conversations with students, providing guides, and learning materials (primary and additional), and contact with the course administrator (Tangkittipon *et al.*, 2020).

   In the next section, we look at the evidence of the peer modeling concept in chatbots.

### 2.5.4 Evidence of use of peer model in chatbots

We have seen in the earlier section 2.3 that peer modeling is used to model the learning experiences. We can see some evidence that researchers and chatbot designers consider the use of peer modeling in chatbots for building self-efficacy in subjects. Consider the example of the health chatbot (Zhang *et al.*, 2020) that could motivate users to adopt good exercise habits and exercise goals. In such situations, the authors recommend narrating the successful experiences of the users to the other users to build self-efficacy among other users concerning exercise and good health habits (Zhang *et al.*, 2020). As we know that by using a peer model,

[4] Frequently asked questions

students can feel close to students having similar backgrounds and experiences. Such students feel open and receptive to receiving support and advice from similar students (Yorita *et al.*, 2019). Efforts have been made to adapt the personality of the chatbot to match with personality and traits of the user to provide the right kind of emotional support. Such chatbots could adapt their personality in real time with the use of powerful algorithms while interacting with users and learning about user traits at the same time (Yorita *et al.*, 2019).

In the next few sub-sections 2.5.5, we look at the basic structure of chatbots. In subsection 2.5.6 we look at the chatbot design factors that build intrinsic motivation that is proposed by researchers and chatbot designers.

### 2.5.5 Basic structure of chatbots

*Chatbots are software programs that can understand the context of users' questions and respond to them in text and voice messages* (Veglis and Maniou, 2019). Chatbots are often termed conversational agents which is a very broad term. A conversational agent is defined as "A software program which interprets and responds to statements made by users in ordinary natural language. It integrates computational linguistics techniques with communication over the internet" (Nuseibeh, 2018, p. 1). Conversational agents are classified into chatbots and goal-oriented dialog agents. A goal-based agent performs a certain task by taking short dialog instructions from the user. For example, Alexa playing a song (Nuseibeh, 2018). In this review, we mostly refer to text-based systems which are mostly used in the education industry as observed from the literature review. These chatbots can understand the keywords from the user's interaction and then use different advanced machine-learning techniques to respond to the end-users by generating appropriate responses based on the end-user's needs (Janarthanam, 2017; Veglis and Maniou, 2019). Figure 14 describes the basic anatomy of a chatbot. The chatbot has a front-end user interface that the user uses for the input of text or voice to the chat service. This user interface can be either a web page, chat application, or mobile app. The chatbot service receives the text input which is parsed and based on the presence of some keywords some rules are fired and a response is generated and sent back to the user interface. Sometimes advanced algorithms concerning natural language processing techniques are used to detect the sentiments/topics from the user request and custom responses are sent back to the user (Borisov, 2018; Veglis and Maniou, 2019).

Natural language processing (NLP) refers to a computer system's ability to understand the text and spoken words/language just like human beings do. It is part of Artificial Intelligence (IBM Cloud Education, 2020). NLP consists of statistical, machine, and deep learning techniques that help computers to understand and process human language as text/voice and to understand the meaning/context, and sentiment surrounding the user's intentions (IBM

Cloud Education, 2020). Understanding the science or algorithms behind these techniques is not in the scope of this literature review.

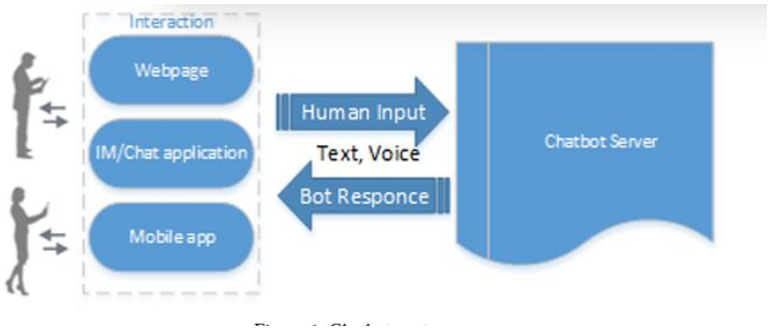



Figure 14 Basic chatbot structure (Veglis and Maniou, 2019).

The chatbot interactions between humans and chatbots can be classified into two dimensions: locus of control and duration of relation (Følstad, Skjuve and Brandtzaeg, 2019). The following are two types of loci of control: -

1. Chatbot-driven dialog: in this type of interaction the chatbot is always in control of the conversation and usually drives it. Such chatbots provide a limited number of controls or inputs and have scripted branching paths and alternatives for conversations with humans. For example, chatbots provide standard menus and buttons for user inputs. Such chatbots are used in marketing and as coaches or guides (Følstad, Skjuve and Brandtzaeg, 2019).
2. User-driven dialogues: Some chatbots allow more flexibility in terms of inputs from users and are thus user-driven. They can also respond to variations in different user inputs. This is more challenging to build technically since the chatbot must understand the user's intent in a particular request or a whole request and then respond adequately (Følstad, Skjuve and Brandtzaeg, 2019). Examples of such chatbots are customer service chatbots and Google Assistant.

In the next section we see the chatbot design factors based on Self Determination Theory from literature.

### 2.5.6 Chatbot design factors for intrinsic motivation

There are many direct observations in the literature on chatbots and conversational agents concerning the use of Self Determination Theory. Researchers and human-AI or human-computer interactions expert suggests that it is very important to consider human psychological and ethical considerations while designing such experiences otherwise the user experiences will be less than optimal (De Vreede, Raghavan and De Vreede, 2021). Human AI design researchers have given certain guidelines for designing chatbots and conversational agents (CAs) to enhance intrinsic motivation and well-being among humans (De Vreede, Raghavan and De Vreede, 2021; Yang and Aurisicchio, 2021). These design factors will help

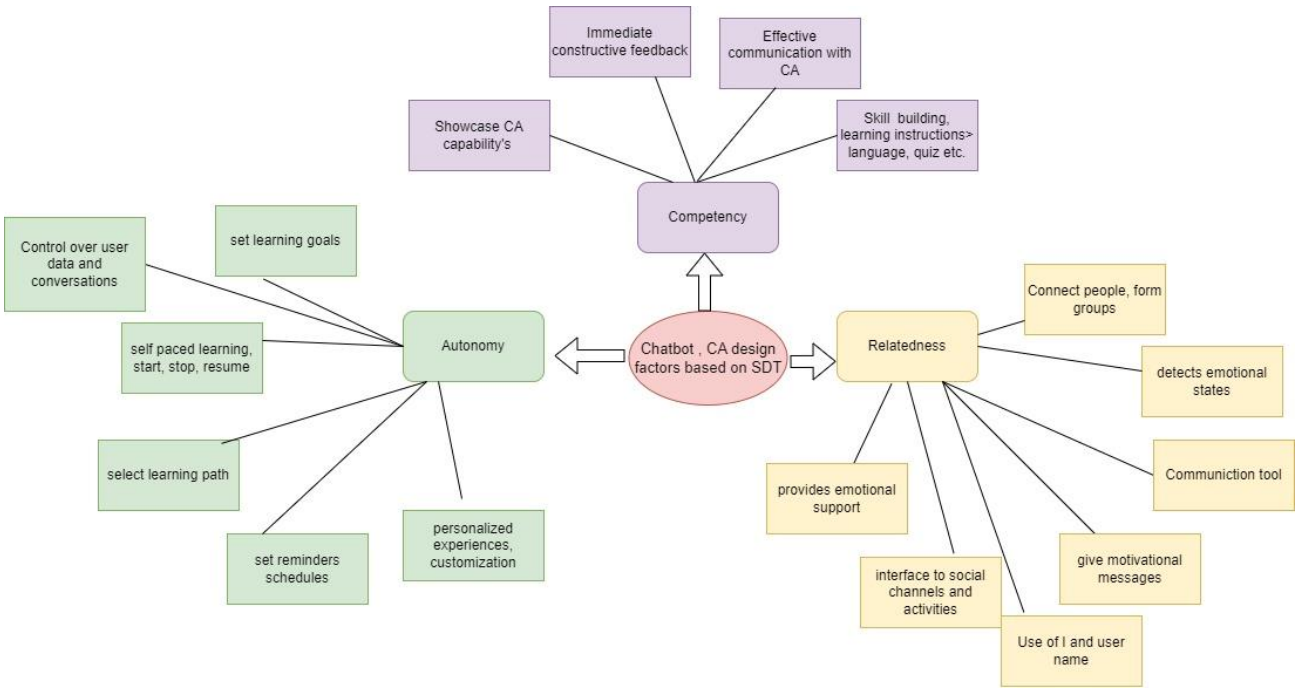
other researchers and chatbot designers to build intrinsically motivating conversational AI experiences. Researchers have interviewed real CA users and tried to understand the psychology of these users concerning ARC's needs of the Self-Determination Theory concerning their CA/chatbots usage (Yang and Aurisicchio, 2021). The data was analysed from the interviews and translated into points that covered the ARC needs of the end-users and the features that promoted or undermined these needs (Yang and Aurisicchio, 2021). Following are the points from the papers that provide design factors for conversational agents (CA's) and chatbots based on Self Determination Theory. In these papers, the design factors are given for Conversational Agents (CAs). But we can see that chatbots are a special type of CAs (Nuseibeh, 2018) and we can thus use these design factors for chatbots also.

1. User autonomy is granted when users have more control over the conversations with the conversational agent (CA)/Chatbot. Having control over the conversation with users means that they can ask relevant questions and get a valid response from the CA/chatbot (Yang and Aurisicchio, 2021). It is not always that the agent must take the lead and ask questions to the end user. The chatbot must be flexible enough to allow users to take turns and let users ask questions or have doubts (Yang and Aurisicchio, 2021). One way to solve this issue is to allow students to customize their user experience for example how they want their responses to be presented by the chatbot or agent (Yang and Aurisicchio, 2021). For example, when the user types or wishes *good morning*, then the CA/Chatbot can be customized to deliver the custom news, weather, and plan for the day. All these things can be set by the user before the interaction (Yang and Aurisicchio, 2021). The researchers (Yang and Aurisicchio, 2021) suggested that more control can be given to end-users by giving them options to customize the conversations; providing explanations for the response of the conversational agents; to make the NLP technology better / more accurate to understand the request or question of the users (Yang and Aurisicchio, 2021). Another point that gives a feeling of autonomy to users is to provide a personalized user experience (Yang and Aurisicchio, 2021). CA/Chatbot can learn from the past behaviour of the users and can provide a custom-made experience (Yang and Aurisicchio, 2021). For example, if a user likes to play a certain song, then next time the conversational agent would automatically recommend and play that song (Yang and Aurisicchio, 2021). Also, users should have more control over their data usage. That means how, when, and where their data is used in the conversational agent (Yang and Aurisicchio, 2021). If data transparency is not there, then users lose trust and feel less control over their data (Yang and Aurisicchio, 2021). The CA/Chatbot should give the users information about what data was collected, and where it was stored. The user should also be allowed to edit or delete their data (Yang and Aurisicchio, 2021). In high autonomy chatbot situations, the user can ask for or request additional information (De Vreede, Raghavan and De Vreede, 2021). In

addition, if something goes wrong during the CA/Chatbot interaction, then an explanation can also be provided to the user as to why the CA/Chatbot could not complete the task (Yang and Aurisicchio, 2021).

2. A CA shows high relatedness when it refers to the user with its name throughout the conversations and refers to itself as "I". In such a situation the CA/Chatbot also has an avatar or profile (De Vreede, Raghavan and De Vreede, 2021). Relatedness is promoted with a CA/Chatbot that provides a platform for social interaction (Yang and Aurisicchio, 2021). For example, CAs can be used as a communication tool to connect with other users (Yang and Aurisicchio, 2021). They can also serve as an interface to social channels i.e., posting news to channels, and hearing community news (Yang and Aurisicchio, 2021). They can also be used to facilitate social and engaging activities with loved ones. Chatbot-based kids' games can be used by parents to connect with their children (Yang and Aurisicchio, 2021).
3. In a high-competency environment, practice tasks should be given along with a full explanation of the task to users or students (Yang and Aurisicchio, 2021). Also, it is a good practice to tell users about the full capabilities of the chatbot before their use. These capabilities can be introduced in the conversation itself rather than knowing from the outside world. Thus, it is better to set expectations about the CA/Chatbot from the start. If users are aware of the full features of the CA/Chatbot then they feel capable to use it (Yang and Aurisicchio, 2021). Communication with CA/Chatbot should be effective otherwise users could lose interest in them (Yang and Aurisicchio, 2021). The users should be able to ask the questions to the CA/Chatbot flexibly and not with exact keywords. Also, the CA/Chatbot should be able to accurately learn the context of the user's question and reply correctly (Yang and Aurisicchio, 2021). The replies of the CA/Chatbot should have a human touch and emotions naturally (Yang and Aurisicchio, 2021). The CA/Chatbot should present the points to the user in an informative and concise manner and the use of words should be kind and socially appropriate (Yang and Aurisicchio, 2021). If such points are not followed, then the users might reduce their interest in the CA/Chatbot conversations. They also might not feel competent to use CA/Chatbot (Yang and Aurisicchio, 2021). Figure 15 highlights the main points or design factors found in the literature review that builds intrinsic motivation concerning self-determination theory in chatbots and CA. In Figure 15 purple components highlight points related to competency. In Figure 15 yellow components highlight points with relatedness. In Figure 15 green components highlight points with autonomy. These factors are from current sub section as well as from section 2.5.1.

Figure 15 Chatbot design factors based on the SDT from the literature.




### 2.5.7 Challenges, limitations of chatbots

In the previous chapters, we saw that chatbots have been steadily used in the education field for various learning activities. The chatbots and conversational agents are being designed for promoting intrinsic motivation among students and end-users. But there are certain challenges concerning chatbots. Autonomy control in conversational agents and chatbots is a rising challenge. Giving users more control over the chatbot or agent means that the chatbot would do what is told by the user (Yang and Aurisicchio, 2021). That means the intelligence of the chatbot is less. If the intelligence of the chatbot/CA is high, then the end-users feel that the Chatbot/CA is hiding information from them. Hence designing an intelligent Chatbot/CA with optimum control and autonomy is a challenge that is faced by chatbot designers (Yang and Aurisicchio, 2021). If the chatbot design is not accurate then the users might perceive less control (perceived autonomy) over the chatbot interactions (Nguyen, Sidorova and Torres, 2022). For example, the chatbot has a limited set of defined user intentions and keywords (Nguyen, Sidorova and Torres, 2022). All these intents and keywords are not usually told to the user at the start of the interaction. In this way, the user might not use correct words while formulating a request and the chatbot might fail to recognize the user's actual intention. Hence the chatbot might ask for more information or other input from the user (Nguyen, Sidorova and Torres, 2022). Thereby increasing the interactions with the user. Because of this experience, end-users might feel out of control (Nguyen, Sidorova and Torres, 2022). All these

factors need to be considered while designing chatbots. Another issue is with the relatedness factor in Chatbot/CA. Many people don't find it useful to use Chatbot/CA as communication tools and interfaces to social channels as they would prefer to use their mobile phones and other conventional communication devices and social media channels CA (Yang and Aurisicchio, 2021).

People also don't feel safe and find it difficult to trust sharing their data and messages with users on social media networks and additionally with the Chatbot/CA (Yang and Aurisicchio, 2021). If the chatbot is built with advanced capabilities like personalization in learning processes, then students' expectations from the chatbot are high and they might often compare the chatbot with the actual classroom teacher (Lidén and Nilros, 2020). Despite their user engagement and personalization features, it is observed that students lose interest over some time in interacting with the chatbot (Winquist and Carlson, 2014; Fryer *et al.*, 2017). The reasons can be due to the novelty effect and due to comparison with the human tutors (Winquist and Carlson, 2014; Fryer *et al.*, 2017). Also, if the students think that the chatbot doesn't provide any value or serve its purpose then they might not use it (Lidén and Nilros, 2020). Students might just prefer a regular website or other devices for their learning purpose instead of a chatbot (Lidén and Nilros, 2020). Considering these above points, futuristic educational chatbots should be designed for a better experience, engagement, and intrinsic motivation so that they keep the students motivated in learning.

## 2.6 Gap found in the literature review.

In this section we look at the key themes that define the research problems in the literature review concerning different dimensions of the literature review for example motivational issues in Flipped Classroom (FC), chatbots use in education and FC, chatbot design guidelines concerning intrinsic motivation and peer modeling concepts and self-regulated learning. The research problems or gaps identified then direct us to the need to solve the problem of intrinsic motivation in FC which is given in red colour (point 5), and which addresses the focus or need for further research work on this topic. Figure 16 showcases the key themes of the gaps found in the literature review. Let us look at the points one by one in detail: -

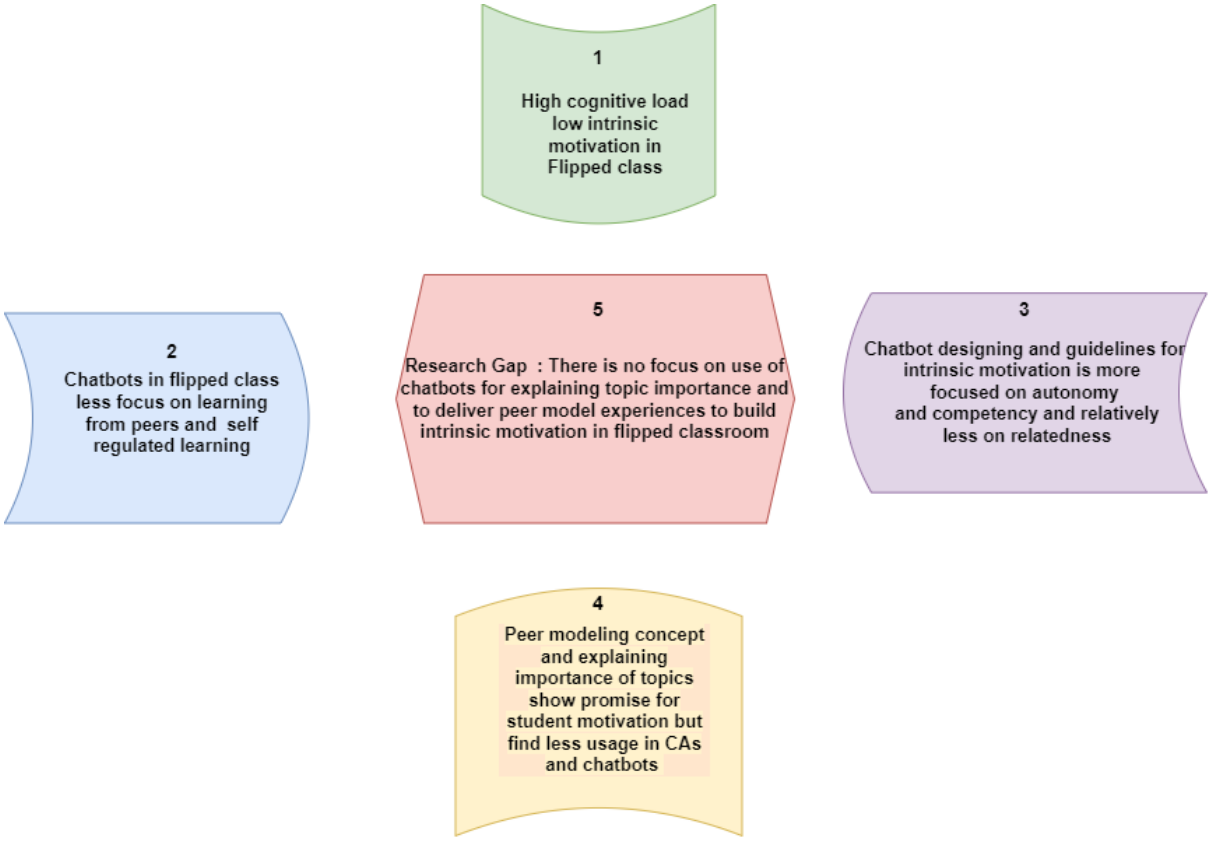



Figure 16 Key themes of gaps found in the literature review along with research focus.

1. In section 2.1.2 we have looked at the motivational challenges faced by students in FC. Students must prepare a lot before coming to FC. They must read preparation materials and take pre-class quizzes (Triantafyllou, Timcenko and Kofoed, 2015). Also, home preparation in an FC increases the preparatory and information load of the students. Thus, intrinsic motivation is found to be low for the students in FC in university courses. For high-quality learning and good educational outcomes, it is therefore important to build the intrinsic motivation of students in the flipped classroom (Ryan and Stiller, 1991; M. Ryan and L. Deci, 2000). This point refers to the problem shown in point 1 in Figure 16 above.
2. In sections 2.2 and 2.3, the theories concerning intrinsic motivation are presented. From the theories of Self Determination (SDT) and Peer modeling, we learn that by using different techniques and factors in learning objects and teaching methods we can build or enhance intrinsic motivation among students or subjects. The theory of SDT says that if the three psychological needs of autonomy, relatedness, and competency (ARC) are supported in students/subjects then intrinsic motivation can be promoted in them (M. Ryan and L. Deci, 2000). Section 2.4 presents all the factors from the intrinsic motivation theories that affect the ARC needs of humans and hence promote intrinsic motivation among subjects.

3. From a thorough investigation of different types of chatbot examples in education and other fields, it is found that current chatbot features can support all three ARC needs of students (Please refer to section 2.5.1 for the features). Thus, chatbots have the capabilities to induce intrinsic motivation among students. Research experiments on the use of chatbots in a classroom environment have revealed that the performance of students who underwent chatbot-mediated learning was as good as traditional classroom students and these students also demonstrated high levels of intrinsic motivation (Yin *et al.*, 2021). Chatbots also demonstrate a low information overload on users as compared to traditional menu-based websites (Nguyen, Sidorova and Torres, 2022). Hence chatbots are ideal candidates for building intrinsic motivation in a flipped classroom.
4. Chatbots are also being specifically used for flipped class activities as seen in section 2.5.3. They are mostly being used as virtual assistants (Tangkittipon *et al.*, 2020) to support students and deliver quizzes (Hew *et al.*, 2021), answer questions/FAQs, and solving of case studies (Huang, 2019). The chatbots that are discussed in the literature review have features that support the ARC needs of the students (section 2.5.1). When ARC needs are promoted through learning experiences students feel intrinsically motivated (M. Ryan and L. Deci, 2000). There is another important theory which is sub theory of SDT and that is the Organismic Integration theory mentioned in section 2.2. We have seen that in the Organismic Integration Theory, identification regulation and introjected regulation concepts promote self-regulated learning. In identification regulation, a person consciously accepts the value of an activity and self-endorses it, and willingly performs the activity (M. Ryan and L. Deci, 2000; Ryan and Deci, 2020). While in integrated regulation the behaviours are accepted by the person as they value their importance and they do it as a part of their routine. These two concepts promote self-regulated learning and in the long run, the persons doing these activities could also begin to enjoy the activities intrinsically (M. Ryan and L. Deci, 2000). Self-regulated learning is an important part of student autonomy where they take control of their learning and transform their mental abilities into task-related skills (Zimmerman, 2015). Authors (Kusurkar, Croiset and Ten Cate, 2011) state that to build the interest of the students in a learning topic tutors could explain the importance of the topics before the class. Students will then self-endorse the topic and chose to learn it automatically rather than under pressure from tutors and slowly their intrinsic motivation to learn the topic will rise (Kusurkar, Croiset and Ten Cate, 2011). This point refers to the problem shown in point 2 in Figure 16 above.
5. People show higher creativity and engagement when they know that their work or task will be impactful in a positive way for a bigger cause and society (Hewlett, 2009; Pink, 2009). It is therefore important to tell the students the topics or content that they will cover and what mastery and skills they will get by learning the new topic and how they can use it for

a larger purpose. Chatbot with its conversational and motivation-building capabilities can become an ideal candidate to explain the importance of the topics to the students, especially in the flipped classroom where motivation is already low. A chatbot can be used to explain the importance of learning topics/goals to students before they go for the Flipped Class so that students self-endorse and learn these topics by choice and thus make their learning autonomous and self-regulated. So far there is only one example of a chatbot that provides self-regulated learning in a Flipped Class as we see in section 2.5.3. Learning Buddy is a chatbot that is used by students in FC to set goals before they prepare for and attend classes. It allows students to plan and self-regulate their learning and plan before they prepare for the FC. But this chatbot doesn't explain the importance of the learning goals or topics but only helps users to set learning goals before the flipped class (Hew *et al.*, 2021). We see another example of a chatbot that provides motivational and educational messages to motivate students to exercise and set healthy goals. FitBot (Gaag, 2013) allows people to set reminders for exercise and motivates people to follow their exercise regimes by sending educational and inspirational messages about the importance of exercise and what side effects can happen when exercise is not done. But such type of chatbot is not seen in Flipped Classroom. This point refers to the problem shown in point 4 in Figure 16 above.

Peer modeling is another very promising concept that is used to impart self-efficacy, confidence, and competence among students concerning learning tasks and assignments. It is described in section 2.3. Students' self-efficacy increases when they see a similarly abled peer succeed in their tasks. By observing such a peer students feel that they can also perform the same task successfully (Bandura, 1997; Zimmerman, 2000; McQuiggan, Mott and Lester, 2008). Peer modeling is also positively related to intrinsic motivation (Ohtani *et al.*, 2013). Peer modeling has shown good results in improving the self-belief of Japanese students in English language learning after watching the videos of Japanese students telling them that English language learning is fun and it is fine to make mistakes while learning (Murphey and Arao, 2001). Giving real-world usage examples of concepts is highly motivating and inspiring to students if the task that they are doing is impacting their work or an organization in a positive way (Hewlett, 2009; Pink, 2009). Hence peer models can also narrate examples where their work related to their learning topic positively impacted an entity or society.

6. Students' competency feeling increases when they see a similar peer succeed at a task. Peer modeling can be used as a scaffolding strategy in problem-solving which helps to create a perception of optimally challenging tasks thereby promoting intrinsic motivation among students (Bandura, 1997; Belland, Kim and Hannafin, 2013). Now computer systems don't use any peer modeling to help students perceive how simple or difficult the task is (Belland,

Kim and Hannafin, 2013). Section 2.3 gives certain examples of how the peer modeling concept is implemented in different technologies for example using videos, and intelligent tutoring systems. Peer modeling techniques are delivered as narratives. These narratives can be recorded in videos or written text and these narratives can have the following attributes (Bandura, 1997; Belland, Kim and Hannafin, 2013). For example: -

- The narratives should suggest the skills and knowledge level of the peer.
- The action or strategies and cognitive abilities required to solve the task.
- The peer faced challenges in the problem and persistently solved the problem.

References:(Bandura, 1997; Belland, Kim and Hannafin, 2013)

This point refers to the problem shown in point 4 in Figure 16. Giving real-world usage examples of concepts is highly motivating and inspiring to students if the task that they are doing is impacting their work or an organization in a positive way (Hewlett, 2009; Pink, 2009). Hence peer model can also narrate experiences where their work related to their learning topic positively impacted an entity or society.

7. In section 2.5.6, we see that researchers have given guidelines and factors on what features and designs to incorporate in the chatbots to build them for promoting intrinsic motivation among end-users. The factors focus mostly on autonomy and competency-related design factors (Yang and Aurisicchio, 2021). Relatedness concerning the connection with others with the use of a chatbot is not much preferred by the end-users (Yang and Aurisicchio, 2021). Users don't feel safe sharing their personal information on social media and with a chatbot. Users prefer to use conventional messaging and communication channels for communicating with friends and family. Users show little motivation to use CAs or chatbots for social purposes (Yang and Aurisicchio, 2021). Also, this factor of relatedness is still in its infancy and not much discussed while designing CAs and chatbots (Yang and Aurisicchio, 2021). This point refers to the problem shown in point 3 in Figure 16. Peer modeling is used to narrate the learning experiences of students as role models to other similar peers to build self-efficacy and motivation among them (Bandura, 1997; Belland, Kim and Hannafin, 2013). Thus, peer modeling can serve as a good concept to build relatedness among students with the use of chatbots. The use of peer modeling to connect with students for learning is not yet explored in chatbot designing for intrinsic motivation. Chatbots could narrate the experiences of similar peers in text or voice format to the other students to build self-efficacy and motivation. Thus, the concept of the peer model shows promises in the use of chatbots to build intrinsic motivation among students and needs to be further explored and investigated in the human-computer interaction field concerning chatbots.

# Chapter 3: Research Methodology

The research process in the Ph.D. thesis follows the design science research methodology to conduct and present its research work. "Design science research is a research model for problem-solving and is focused on creating innovative solutions to solve real-world problems and generate new design knowledge" (Hevner *et al.*, 2004; vom Brocke, Hevner and Maedche, 2020, p. 1). In information systems, design science research contributes to the development of research artifacts that solve or cater to a particular business-Information Technology problem (March and Smith, 1995; Hevner *et al.*, 2004; Iivari, 2005; Hevner, 2007; Peffers *et al.*, 2007; Baskerville, 2008; Carcary, 2011). These artifacts are usually implementations of the design science process as shown below in Figure 17.

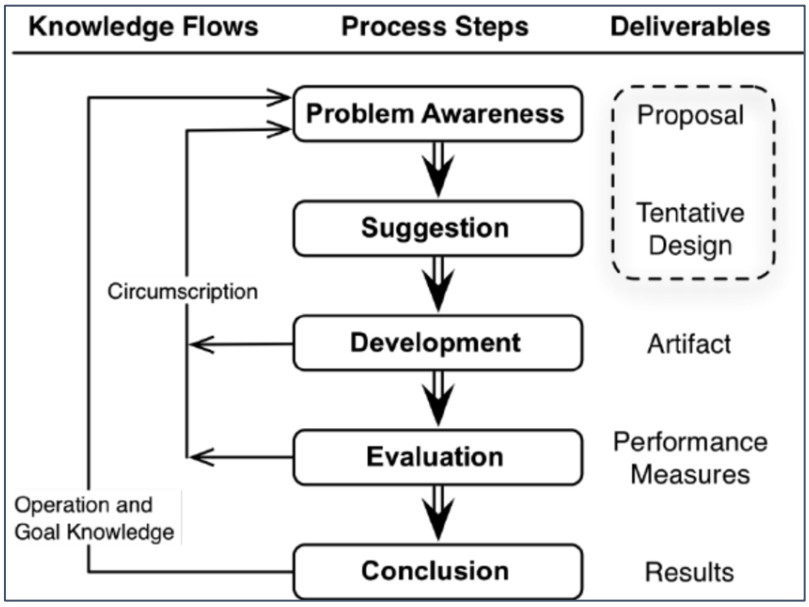



Figure 17: Design Science Research Process Model (Hevner and Chatterjee, 2010)

A case study is prepared to get an in-depth understanding of a single or small number of use cases from a real-world context (Yin, 2012). It is defined by Yin (Yin, 2009, p. 18, 2012) as follows: "*An empirical inquiry about a contemporary phenomenon (e.g., a "case"), set within its real-world context—especially when the boundaries between phenomenon and context are not evident*". The case study is also used to evaluate the single or multiple instances of the research artifact (Peffers *et al.*, 2007). To confirm the challenges faced in FCs and to evaluate the proposed chatbot tool in a real-world context, a case study about the Business Intelligence module in the Master of Business Information Systems program from FHNW, Switzerland is prepared and studied carefully. The data for the case study is collected from diverse sources like homework documents, LMS activity logs, student interviews, and surveys. The activity logs are studied from the year 2015 to 2018.

The details of data collection techniques can be found in Appendix 8.10. The details of the presented case study with the survey and analysis results can be found in detail in Chapter 4 FHNW Case Study.

The steps in the design science research methodology (DSRM) are discussed in the context of the current Ph.D. research work.

### Identification of problem

In the awareness phase, an interesting research problem is found related to business - IT that could be related to a new problem or an existing one (Hevner and Chatterjee, 2010). Mostly problem-solving research topics from the field of information systems research are selected in the DSRM (Benbasat and Zmud, 2003; Offermann *et al.*, 2009; Hevner and Chatterjee, 2010). The problem is usually relevant to some organizations, and departments and can be generalizable to more than one entity (Lee and Baskerville, 2003; Offermann *et al.*, 2009). In the awareness phase, the research problem is found out usually by literature in the specific area, and a research statement or question is formulated which lays the foundation of the course of the subsequent research work (Offermann *et al.*, 2009). A literature review is conducted to know the state of the art in the field of the research problem (Offermann *et al.*, 2009). A literature review was conducted in areas of the flipped classroom, intrinsic motivation theories, and chatbot design/features to understand the research problem. Intrinsic motivation is important for good learning outcomes. Parallelly in the FHNW case study student surveys were conducted to understand and confirm the motivational and preparatory challenges faced by students in the flipped classrooms. In the intrinsic motivation theories literature review it was found that peer modeling and concepts from Organismic integration theory such as an explanation of the importance of the topic to students have a good potential to enhance the intrinsic motivation of students in the flipped class. Both concepts are not used in the chatbot design features by human-computer interaction researchers to build intrinsic motivation among flipped-class students. Also, peer modeling has not been used to its potential to create a perception of an optimal challenge. To define the research problem and literature gap following research question was synthesized:-

> How can the peer modeling (PM) experiences and explanation of the importance of learning topics (EILT) be used to intrinsically motivate students to prepare for the flipped classroom setup using a chatbot?

This research question further sets the theme of the Ph.D. research work. The objective is to build a chatbot that explains the significance or importance of the learning topic and delivers peer modeling experiences of past students concerning the learning topic to build intrinsic motivation among students in the flipped class. The literature review gap is given in section 2.6 while the research questions are in chapter 1.

## Suggestion, development of the solution

The suggestion phase is a creative phase in which a tentative high-level design of the artifact is prepared with the use of existing or new concepts (Hevner and Chatterjee, 2010). The suggestion phase involves designing the solution proposed to solve the research problem and gap identified in the awareness phase of the design science methodology (Vaishnavi and Kuechler, 2004). The suggestion phase is followed by a development phase. In the development phase, the tentative or initial design is developed into an artifact. This artifact contains the research contribution added to its design (vom Brocke, Hevner and Maedche, 2020). While developing and designing new solutions, existing state-of-the-art techniques from the literature can be taken into account (Offermann *et al.*, 2009). The artifacts can be constructs (vocabulary, symbols), models (abstractions), instantiations (proof of concepts, prototypes, software systems), and methods (guidelines, processes) (March and Smith, 1995; Carcary, 2011). In information systems, artifacts can be UML diagrams, prototypes, wireframes, visual mockups, or a software program (Koppenhagen, Gaß and Müller, 2012).

In the suggestion phase, the chatbot's high-level design was finalized by creating a high-level logical flowchart that showcases the features and the flow of information in the chatbot-student interactions. The chatbot feature requirements incorporated the different concepts from Self – Determination theory, peer modeling, and EILT from the Organismic Integration Theory were also finalized during this phase. These requirements include the design functionality along with the features and their behaviors along with chatbot personality, learning topic content, and the student–chatbot interaction use cases. They also include the mapping of the different student emotional needs of ARC (promoting intrinsic motivation) to the different design features of the chatbot. In the development phase of the chatbot, two prototypes were developed.

The first chatbot is built using the Landbot tool. This prototype was built to explain the importance of the upcoming learning topic along with delivering peer model experiences to students in a real-world context of a flipped classroom. This prototype aims to build intrinsic motivation among students in flipped classes using PM and EILT concepts concerning learning topic preparation. The prototype made using the Landbot[5] tool is developed considering the multi-dimensional modeling (MDM) topic taught in the Business Intelligence class at the master's program at the FHNW, Business School. It showcases the features of peer modeling and EILT and contains a simulation of a similar peer model. The content for the peer modeling was prepared from the content given by past students of the Business Intelligence class. While the significance of the topic was curated from the preparation materials of the

[5] https://landbot.io/

MDM topic and the professor who teaches the class. The second prototype is implemented in Java using the Microsoft Bot Framework [6]to demonstrate similar peer recommendations based on the student's educational and professional backgrounds using the case-based reasoning method. The chatbot proof of concepts is discussed in detail in Chapter 5.

### Evaluation

Once developed, the design artifact needs to be evaluated. The objectives of the solution are compared to the actual test results of the artifact in the real-world context (vom Brocke, Hevner and Maedche, 2020). Any deviations from the expected outcomes both quantitative and qualitative need to be noted and explained (Carcary, 2011). The evaluation phase is always carried out iteratively where at every stage the suggestions are taken into consideration and the artifact is refined (Carcary, 2011). The information technology solution is usually evaluated for its quality, efficacy, utility, and its impact on the end-users of the respective application domain (March and Smith, 1995; Carcary, 2011). A naturalist evaluation technique is one in which the system is tested with real-world users to solve a real-world problem (Sun and Kantor, 2006; Pries-Heje, Baskerville and Venable, 2008). Such a technique accepts all the details of human practice in real-world organizations or setups. Such evaluation is empirically verified by observation and experiences and makes use of case studies, surveys, etc. to take the opinion of the end-users.

Initially, the chatbot was tested in the flipped class on a Multidimensional modeling topic in the Spring semester of 2022. The survey and interview responses quantity were not sufficient to make any conclusions regarding the intrinsic motivation of the students after chatbot interactions. Nevertheless, the results are mentioned in sections 6.1 and 6.2. The chatbot was evaluated by **forty-three** students in the autumn semester of 2022 in the Business Intelligence module. A survey questionnaire based on the Intrinsic Motivation Inventory (Center for Self-Determination Theory, 2022) was prepared to assess and understand the participant's intrinsic motivation and related emotions of ARC. Students were also asked to rate the chatbot features and tell the limitations and suggestions for improvements concerning the proposed chatbot tool. These improvements and suggestions serve as input for refining the chatbot for future work in the next design cycle iteration. The results of the evaluation are discussed in section 6.3. The improvements of the chatbot are discussed in sections 6.4 and Appendix section 8.12. In the current thesis work the improvements are not carried over to the next design cycle phase and it is kept as a matter for future work.

[6] https://dev.botframework.com/

## Conclusion

In the conclusion of the thesis, the high level key results of the evaluation are presented along with the thesis research contribution its limitations, and the future work that needs to be done. The research artifact i.e., the chatbot with the PM and EILT features, the guidelines provided to design and build such a chatbot and the analysis of the evaluation results serve as inputs to the existing knowledge base of chatbots for intrinsic motivation in the flipped class context. The conclusion is presented in Chapter 7. The next chapter describes the FHNW case study in detail.

# Chapter 4: FHNW case study

The research focuses on a real-world problem in the flipped classroom. In the literature review in the section Flipped classroom (FC) problem we see that students face certain specific challenges. The main challenge found is that the workload for preparation outside the classroom is high in FC as compared to the traditional classroom (Triantafyllou, Timcenko and Kofoed, 2015). To validate these findings, I considered the case study of an actual flipped lesson in a real-world context. FHNW, Business School, Olten delivers many graduate and post-graduate degree programs in areas of business, management, and information technology (Fhnw, 2022b). The school runs four bachelor programs and two Masters of Science programs. Most of the courses in these degree programs are practice-oriented courses that also conduct research work and collaborate with industries for projects (Fhnw, 2022b). Many degree courses follow the FC approach. This chapter focuses on the preparation challenges faced by the students at FHNW, Business School.

## 4.1 Generic survey results in detail

To understand how the students prepared for the flipped classroom sessions I conducted an anonymous survey among the students at FHNW School of Business. This survey maps to the problem awareness phase of the design science research methodology where I need to understand the challenges faced by students in the flipped classroom. A questionnaire was sent to all master's students in the School of Business. The number of student submissions for the survey was 142. This survey was primarily conducted online in Google Forms in the year 2017. The followings are the survey questions and answers in detail.

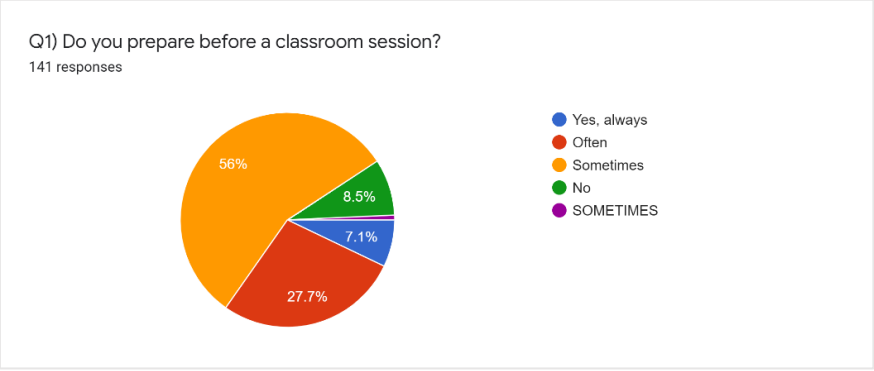



Figure 18 Question related to the frequency of class preparation among students.

1. The students were asked if they prepared before the flipped class. The options given to them were always, often (i.e., frequently), sometimes, and no. Nearly 56% of students prepared sometimes before the class. While 27.7% of students prepared often for the class. Around 8.5% of students did not prepare before the class. While 7.1% of students always

prepared before class. Please refer to Figure 18 for the survey question and answer. This question was asked to understand how many students prepared before the class and what was their frequency of preparation or how often they prepared for the classes.

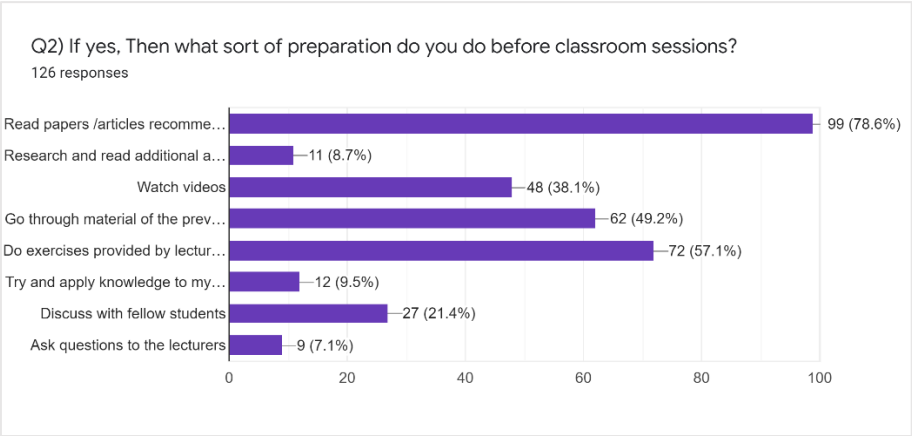



Figure 19 Question related to the type of preparation in FC.

2. Students were asked what sort of preparation they do before classroom sessions. The top five answers were: read papers and articles recommended by the professor, do exercises provided by the lecturers and go through materials from previous lectures, watch videos, and discuss with fellow students. Please refer to Figure 19 for the survey question and answer. This question was asked to understand what sort of preparation students did for their classes.

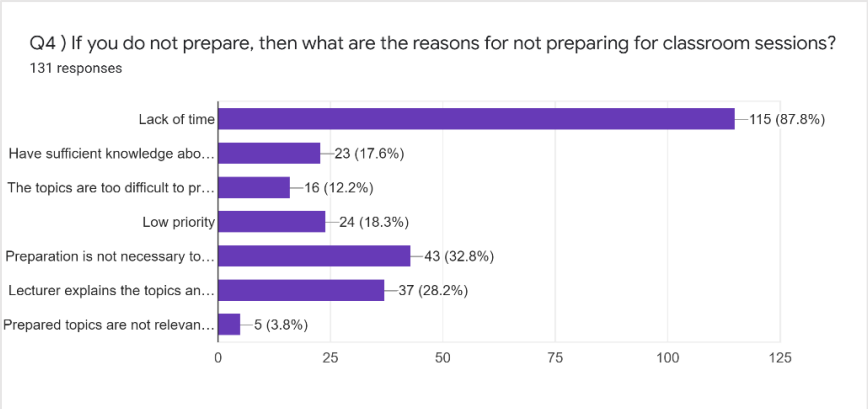



Figure 20 Question related to the reason for not preparing for FC.

3. Next, students were asked the reasons for not preparing for the FC. The top five reasons for not preparing for the FC were: Lack of time, students thought preparation is not necessary to follow the class, lecturer explains the topics anyways, having sufficient knowledge about the topic, and low priority. Refer to Figure *20.*
4. Students were asked the question "Do you have any other reasons for not preparing for the classroom?". This question was asked to understand why students not preparing for the flipped class. Following were some of the outstanding answers:
    - "Sometimes due to laziness", "tiredness"

- “Forget the preparation”
- “Lack of interest due to inadequate teaching methods, leading to demotivation about the subject”.
- no motivation
- too much workload (all modules together)
- motivation, sometimes the content is not so relevant for future work.
- Lack of motivation => preparation looks painful. It's much harder to jump alone in the topic.
- Don't feel like it
- work overload: as it is anyways too much content to repeat or being prepared for EACH class, I feel overwhelmed sometimes and don't manage to do anything than...

It is clear from the students' answers above that there is a high level of workload and a lack of motivation in students concerning flipped classroom preparation. This is also confirmed by the literature review in section 2.1.2.

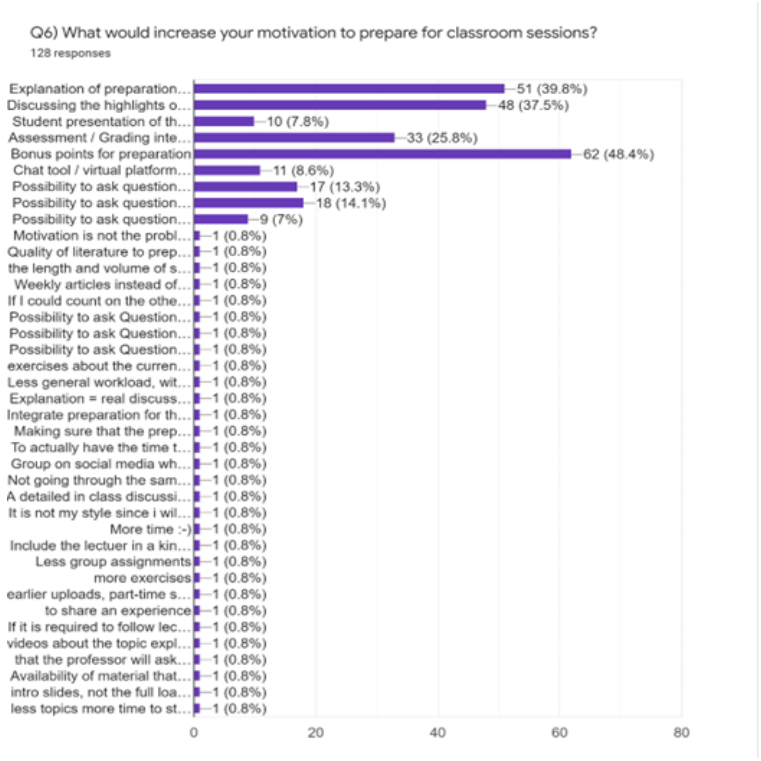



Figure 21 Question related to what would increase students' motivation.

5. A question related to what would increase the student's motivation was asked. The top five answers were as follows: Bonus points for preparation, explanation of preparation of topics for next class, discussion of highlights of an upcoming class, assessment, grading / intermediate exams, and possibility to ask questions to tutor/coach. Someone also mentioned a chat tool / virtual platform. Please refer to Figure 21 for point 5 above.
6. Students were asked, “Do you have any other suggestions/ideas for improving classroom preparation ?” Some of the outstanding answers were as follows.

- Restrict lessons to the most relevant things -> 75%. Leave out the nice to have things and offer that time to us as free time after contact time to study the relevant things or groupwork.
- Shorter preparations which really make sense instead of reading 40 pages of a book which is not discussed in class.
- Often Information can be compressed to 1 A4 sheet. Same reason why Managers often only read the management summary of reports. if I need further information I can still read the article.If the preparation (or even at home assignment) will never be done if they are too complicated or too long. We only needs a quick introduction to be aligned with the class.
- knowing what is important (exam relevant) would be very helpful. Sometimes, there are huge amount of papers to read/provided on Moodle, which are at the end not relevant for the exams and also not very interesting, appropriate for the course's content or coherent. Profs. just choosing some papers and additional reading that Moodle is used at its maximum isn't helpful at all.

From the above points, we learn that students would like to know small and concise points before the lecture rather than reading long preparation materials. Also, they would like to know what important and relevant topics for the exams are.

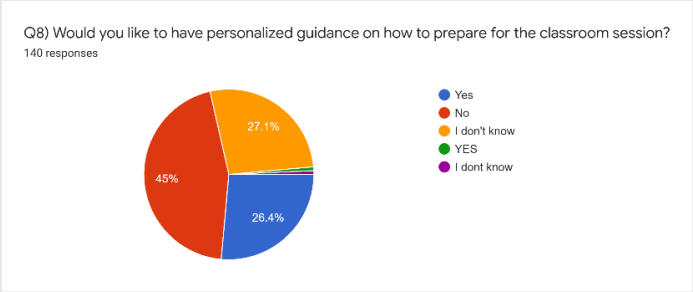



Figure 22 Question related to personalized guidance in preparation

7. Students were asked if they would like to have personalized guidance on how to prepare for FC. Forty-five percent of students said no, while 26.4 percent said yes, and 27.1 percent said don't know. Sixty-three students replied to the next question on how they would prefer personalized learning. Please refer to Figure 22
8. Sixty-three-point five percent of students preferred a combination of a person and a virtual tutor, while 20.6% of students preferred only a virtual tutor, and 15.9% of students preferred guidance by a person or human tutor. Please refer to Figure 23. These questions were asked to know if students would be open to new virtual learning technologies for class preparation.

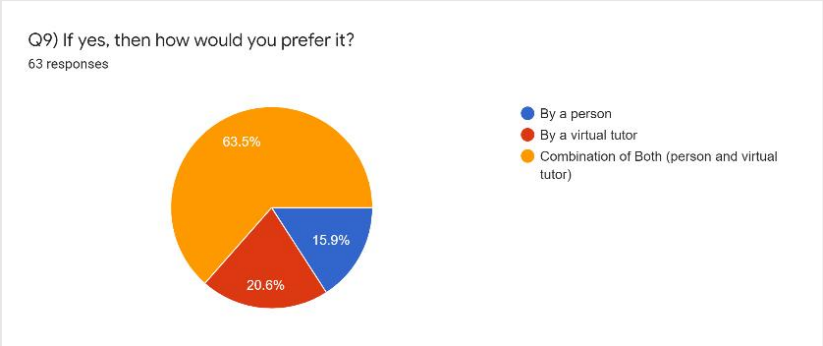



Figure 23 Preferences for personalized learning

9. Next, students were asked why they selected the answer for the above Q9. Following are some outstanding and relevant answers. Student answers for "By a virtual tutor" were as follows: -

- A lecturer may not necessarily be the right person to ask questions to. Rather have a peer to answer questions, like a teacher assistant. Also, may not be necessary to meet in person rather than virtually
- can ask anytime anywhere
- In case a virtual tutor can answer my question the lecturer might not need to be bothered..

Student answers for "By a person" were as follows:-

- Some questions need to be clarified in detail.
- I prefer personal discussions
- we are already enough digital. no need to have virtual tours
- Virtual systems would work in a too structured way - there are still limits on how a artificial system would react on personality of the person. It might give some generic and fitting answers, but it can not create a relation of trust and understanding, that a coaching needs. Guidance is more then just showing some steps that should be done.

Student answers for "Combination of both virtual and real tutors" were as follows:-

- Good combination, so that - if necessary - it can be repeated at home.
- Sometimes its easier to just quickly shoot a message, sometimes its better to talk to a person. I have experience with an online tutor from an online degree and really liked it.

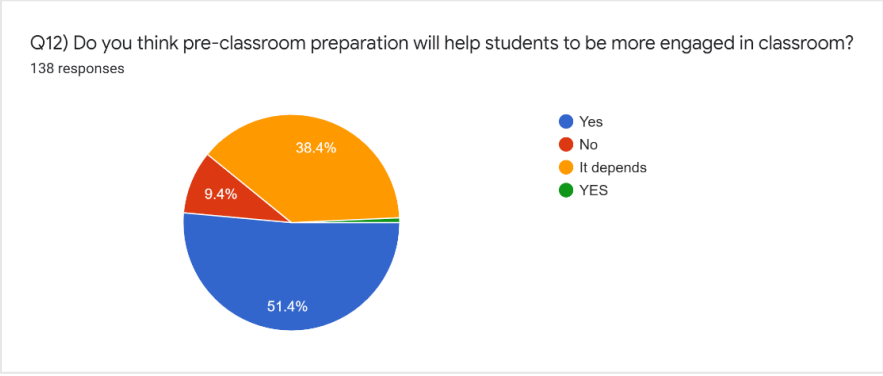



Figure 24 Importance of FC preparation

10. Students were asked if the pre-class preparation helped them to engage in the FC. Nearly 52% thought that pre-class preparation helped them to be engaged in the class, while 38.4% thought it depends, and 9.4% of students thought it did not help. Refer to Figure 24. This question was asked to know students' opinions about FC preparation and whether it helps them to be engaged in the classroom.
11. Next students were asked, "In your opinion, how should preparation be designed to increase student engagement in the class?". Following are some outstanding and relevant answers: -

- Give more clear instructions on what will be relevant in the next class and how it integrates into the schedule
- Clear guidance and reasons why that article is relevant
- Goals must be clear for next lecture, so it allows efficient preparation. Attractive video-material works well for me to get an overview of a topic.
- Giving only the highlights of the study preparation.
- make it interesting!
- It should be short (not a 50 pages article), objective, and told in advance (the day before is not in advance). Also, if we have exercises to practice what we prepared for and get bonus points for it would be nice.
- Homeworks, videos to watch, gamification during the course, studie applied on real scenarios and real companies

Students preferred to have a summary of concise points for preparation rather than long text. They want the material to be interesting with gamification, and videos with real-world examples.

12. Students were asked if they faced any challenges during FC preparation. Following were some outstanding and relevant answers: -

- Lack of time. There are a lot of material from different classes as well as presentations, papers and projects going on at the same time plus being part-time student.
- Motivation is more important than natural talent or inteligence. If the class has some sort of team spirit and well meaning students then an individuals success rate should be far greater (at least in my personal opinion =) ). So for me personally it is always a question of keeping my motivation up and not the be too lazzy (or also not to strict since one might end up with a burn out = ( ).
- Lack of time and motivation.
- Time Management, tiredness
- Lack of time, Lack of organization, lack of consideration, for every class it could be different. But mostly, it is lack of motivation

The key challenges visible were a lack of motivation, lack of time, and a lot of preparation material and workload.

13. Students were asked if they have “Any further consideration for classroom preparation?” Following were some outstanding and relevant answers: -

- If there is a good way to motivate students it would make collaboration during class much more lively. I guess for many lack of time is a blocker for preparation. Also, goals for next lecture is mainly unclear. Giving points or making preparation mandatory would not be a good way to foster it - I guess it would turn into the opposite.
- Please try to focus more on E-Learning, remote solutions.
- Make it fun. Like a game (collecting points), having a quiz, upload a foto of your notes and so on. Put in some little entertainment… people will remember it much more easiy. Also try to include audio as most students have a lot of time to travel to the school-building, they carry iphones etc and anyway listen to music etc… so make us uf that piece of technology.

## 4.2 Generic survey results summary

This sub-section gives the high-level key themes found in the generic survey among master's degree students in FHNW, Business School. The following are the key highlights: -

1. The first theme is related to the types of preparations students did in FHNW. Please refer to Figure 25 with purple-coloured elements. From the survey 78.6% of the students read papers and documents recommended by the tutors; 21.4% of students discussed assignments with peers; 57.1% of the students did exercises given by tutors; 49.2% of students read materials about previous lectures; while 38.1% watched learning videos provided by the tutors and did discussions with their peers. The answers to the survey are provided in Figure 19.
2. The second theme is related to the key reasons students not preparing for the FC. Please refer to Figure 25 with green-coloured elements. The top five reasons for not preparing were as follows; 87.8 students mentioned lack of time; while 32.8% of students said that preparation was not necessary to follow class lectures; 28.2% of students said that the lecturers explain the topics in class anyways. While 18.3% of students thought it was a low priority to prepare for class and 17.6% of students said that they had sufficient knowledge of the topics taught in the class. The answers to the survey are provided in Figure 20. The students were asked an open-ended question on other reasons for not preparing and most of the answers were high workload, lack of time, lack of motivation and interest, and laziness to prepare before class. Another reason that was frequently mentioned by students was that they were given a lot of material and assignments to prepare for the class.
3. Students gave many good suggestions to improve their motivation and interest in classroom preparation. This theme maps to the blue elements in Figure 25. Students gave their opinion that the preparation content and materials were quite exhaustive, and it would help if the content delivered was short, concise, and to the point with a summary of the main concepts. Ideally, if the clear learning goals and importance of upcoming class

topics were given before the class then the students could plan better. Also, it would be better if they got some hints on which topics were important for exam assignments so that they could only prepare for those. The tutors could also give them real-world use cases and examples from companies to build interest in learning the topic. The students have group assignments in different subjects, and it takes away a lot of time and effort. Students would thus prefer to have less group work. Nowadays students use technology and mobile devices to entertain themselves hence they would also prefer to have some E-learning or mobile solution to help them prepare in the classroom. Additionally, some students wanted fun and gamification concepts to be used in classroom preparation tools. Students thought that tutors should not force or keep preparation and home assignments mandatory as it puts pressure on them and impacts their motivation. They would like to have some autonomy in doing their homework. Finally, students suggested that giving them additional bonus points would help them to be motivated to do the learning assignments.

4. Apart from the above themes, students were asked about their opinion on virtual tutors. Students were asked if they would like to have personalized guidance on how to prepare for FC. Forty-five percent of students said no, while 26.4 percent said yes, and 27.1 percent said don't know. Sixty-three students replied to the next question on how they would prefer personalized learning. Sixty-three-point five percent of students preferred a combination of a person and a virtual tutor, while 20.6% of students preferred only a virtual tutor, and 15.9% of students preferred guidance by a person or human tutor. Students felt that a virtual tutor can be connected anytime, anywhere without bothering the human teacher. Some students felt that a virtual tutor might not be efficient to address more details of students in case of complex doubts and hence preferred a human tutor for detailed guidance.

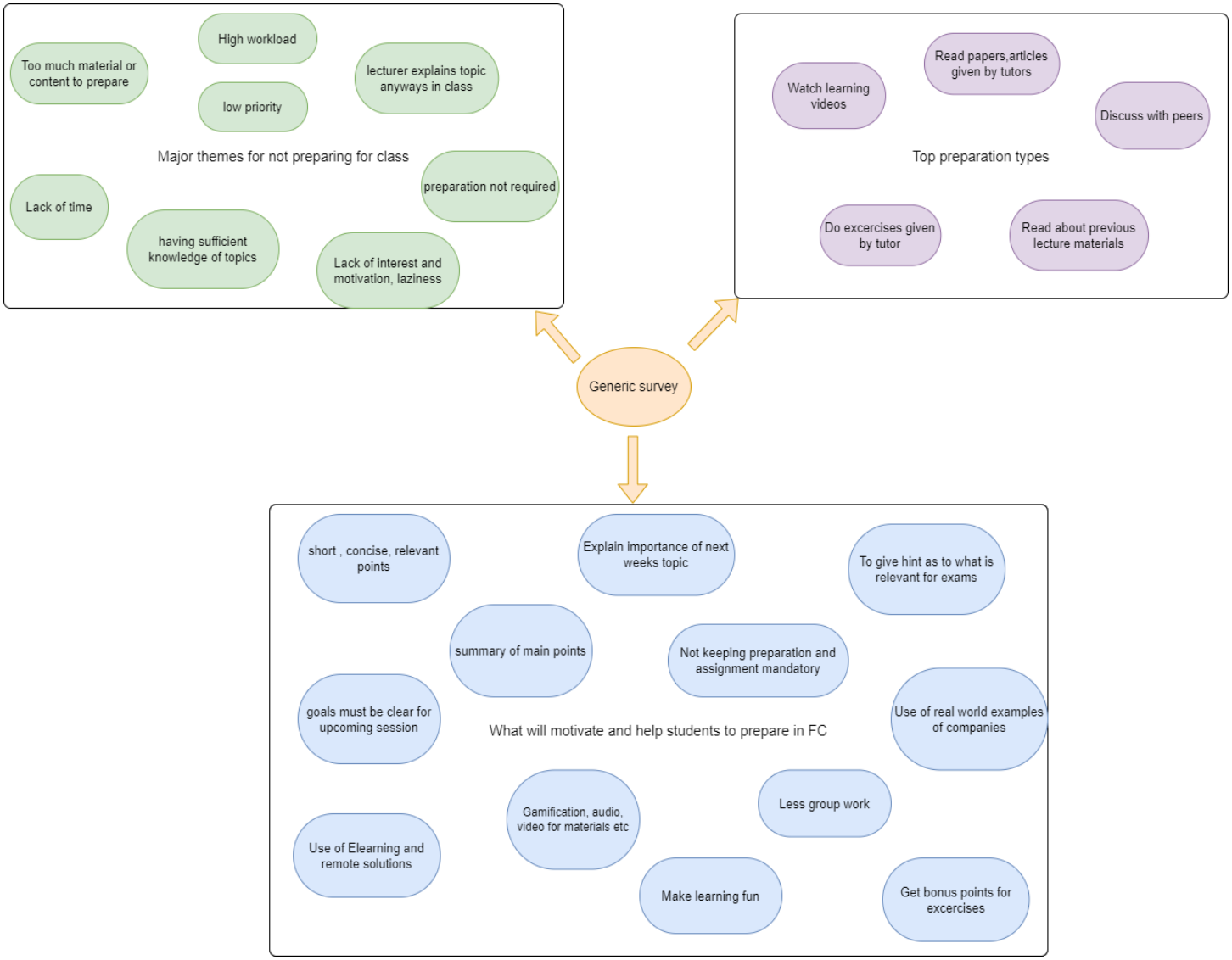



Figure 25 Important themes found in the student survey.

## 4.3 Focus on course business intelligence.

To understand well and analyse the challenges of the students in the Flipped Classroom in detail I selected the course “Business Intelligence” in the degree program Master in business information systems. Master in business information systems is an international course in the School of Business, FHNW, that is designed for ambitious students who want to pursue a career in Business and Technology. As it is an international course, it provides part-time and full-time course options for individuals who work in the industry as well as non-working people from diverse countries. This master's program is an international program that is attended by students from diverse cultural, technical, and professional backgrounds (Fhnw, 2022c). It is a professionally oriented course that is developed in close collaboration with industry experts and researchers (Fhnw, 2022c). Some of the students either already work for organizations and companies or plan to work in the future in professionally oriented jobs.

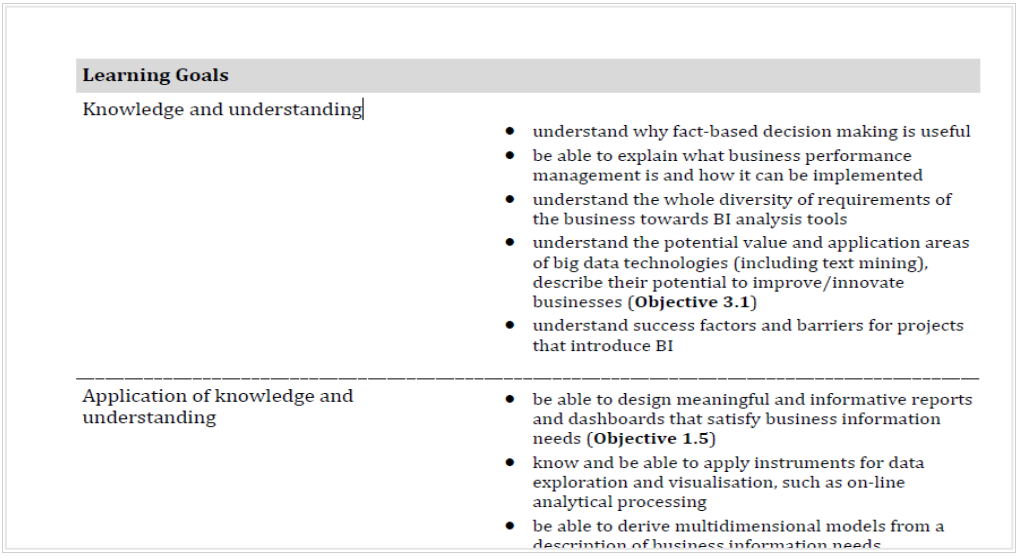
For this case study, I select the “Business Intelligence (BI)” module to know how students prepare and what challenges they face in-class preparation. The reason for selecting the module is that it is a core module, and it is a highly technical subject it deals with supporting business decisions by uncovering meaningful insights from the business data so that the business stakeholders can take timely decisions and make the business processes more efficient in the industry. Thus, this module is useful for business as well as technical people and attracts working and non-working individuals from different educational and professional backgrounds namely Computer Science, Information Technology, Engineering, Management, and Business Administration (as observed from the surveys). Also, this BI module uses the Flipped Class technique. The business intelligence module is a core module that is highly technology oriented. The concepts in this module are used by multiple business stakeholders to extract meaningful insights from raw data (Fhnw, 2022a). This module teaches several technical fundamental concepts in the Business Intelligence area which has the potential to impact several business processes positively in diverse industries. This topic is highly technical and deals with several latest technology trends opening multiple job opportunities for students. Hence it is attended by students from both business and technology backgrounds.

Many lessons from the Business Intelligence class follow flipped class lessons where the home workload is high for students and the preparation material is quite intense. For many important topics, preparation materials and homework quizzes are delivered via Moodle LMS. Students need to go through the homework to understand the concepts taught in the classroom. The subjects are highly technical and there is a final project assignment that is done in collaboration with the industry. Thus, this module is a very important one for the career/professional growth of the students and can open a lot of good career opportunities for prospective students.

The data for this case study is derived from student surveys, interviews, and direct observations in the classroom. I was a student in this course, and I had taken the same module in my master's program at FHNW. I have also used direct process observation techniques while I was working at the Business School, FHNW.

### 4.3.1 Module description and learning goals.

At the start of the semester, the module description for the BI class as well as other subjects in the degree programs is distributed to the students so that the students come to know the topics covered in the course as well as the learning goals associated with it. This module description is delivered or uploaded on Moodle. Please refer to Figure 26 for the current module description for the BI class. Each learning goal has certain competencies or knowledge associated with it which empowers students to assess mastery over the topic and apply that knowledge in practice. The module description is detailed and gives the main points and is not very easy to understand in terms of relevance in the practical world. Also, it gives detailed information about the learning goals at the same time and might generate information overload among students. It also does not map the learning goals to the topics of flipped lessons or topics in a descriptive way. Rather this generic way of describing the learning goals will not generate any curiosity or interest in the minds of the students. Also, the module description is not capable of promoting the importance of the topics and tasks, mastery and skills gained by students and how they can impact the larger purpose like academics, company problems, and society at large with those skills and competencies which is important to maintain interest and intrinsic motivation among students. In the FHNW surveys and student interviews, it was revealed that students were not much happy with the Moodle interface and found its structure confusing.



| **Learning Goals** | |
|---|---|
| Knowledge and understanding | • understand why fact-based decision making is useful<br>• be able to explain what business performance management is and how it can be implemented<br>• understand the whole diversity of requirements of the business towards BI analysis tools<br>• understand the potential value and application areas of big data technologies (including text mining), describe their potential to improve/innovate businesses (**Objective 3.1**)<br>• understand success factors and barriers for projects that introduce BI |
| Application of knowledge and understanding | • be able to design meaningful and informative reports and dashboards that satisfy business information needs (**Objective 1.5**)<br>• know and be able to apply instruments for data exploration and visualisation, such as on-line analytical processing<br>• be able to derive multidimensional models from a description of business information needs |

Figure 26 Module Description of the BI class

### 4.3.2 Analysis of Moodle logs

The first survey was a generic one that conveyed the high-level issues faced by students in the FHNW degree programs. But it did not give a clear understanding of how students interacted with the learning materials as well as how they solved the pre-class quiz on the learning management systems (LMS). For this, I analysed the anonymous logs of the quiz "*Descriptive statistics*" in the flipped lesson "*BI Reporting and Dashboarding*". To understand how students took the quiz I analysed the quiz logs for consecutive past four years for the same quiz. The Moodle logs contain information about the student ID, the status of the quiz, the start time and end time of the quiz, the total time duration required for the quiz, and the number of attempts of the quiz for every user. It is also possible to see how much time each attempt for a question in a quiz took for every user attempt. It also contains answers for every attempt and the grade for every question/answer for the quiz for every user who attempted the quiz. When the user accesses any resource, for example, a file uploaded on Moodle, then this information is also stored in Moodle logs. For example, the date/time at which the resource was accessed, the file/resource name, and the user id of the user who accessed the file. It is possible to know from Moodle logs how many students enrolled for the quiz and how many did not. Using this information from the Moodle logs, the following were the observations about the student behaviours with the quiz: -

1) It was observed that not all students finished the quiz before the class for practice. Many students did it during class, after the class, or just before the final exams. In addition, students took multiple attempts at the same quiz one or more times. Some attempts were in progress status and were not finished.

2) Many students used a trial-and-error method to come to the correct answer. This was visible in the logs of the individual questions where multiple submits were done within a few seconds apart from each other to get to the correct answer. The time taken for the attempt of a single question was in a few seconds. This indicates that students did not spend time thinking about the correct answer.

3) Some students skipped several questions in the quiz while some attempted the quiz but did not answer all the questions in the quiz.

Table 3 gives us the different attempts made by students for the quiz descriptive statistics in the year 2015-2018. The first column represents the year in which the quiz was conducted. The second column gives the total number of students who finished the quiz before the class. The third column gives the number of students who solved the quiz questions with the trial-and-error method for one or more than one question. The last column gives the number of students who did not attempt the whole quiz plus the students who attempted the quiz but did not complete it.

| Year | Students who finished quizzes before class | Students who accessed reading material before class | Students who did trial and error for at least 1 question | Students who did not complete or attempt at least one question in the quiz. | Total students who did not attempt the whole quiz | Total students who attempted the quiz |
|---|---|---|---|---|---|---|
| 2018 | 9 | 23 | 14 | 4 | 7 | 21 |
| 2017 | 8 | 25 | 10 | 9 | 7 | 30 |
| 2016 | 15 | 20 | 12 | 10 | 6 | 25 |
| 2015 | 18 | 31 | 16 | 7 | 4 | 36 |

Table 3 Statistics for the quiz "Descriptive Statistics"

Figure 27 Detailed Moodle log analysis of the class of October 2018. depicts the detailed statistics of the class of 5th October 2018. The data was calculated from the student interaction traces with different preparatory materials and assignments found in the Moodle logs.

Figure 27 Detailed Moodle log analysis of the class of October 2018.

| Observations | Values | Students who did trial and error/multiple attempts within same time to come to right answers (1 or many) | Students who had incorrect answers for questions ( 1 or many) | Students who skipped some questions/not completed questions ( 1 or many) | Students who had partially correct answers (1 or many) |
|---|---|---|---|---|---|
| **21 students of 28 attempted ( 28 students have currently enrolled in course)** | | | | | |
| **No of students who did not attempt at all the quiz** | **7** | | | | |
| Total attempts of quiz | **25** | | | | |
| | | | | | |
| **Total No of students who finished atmost one attempt** | 15 | **14** | 2 | | 10 |
| | | | | | |
| No of students who finished atmost one attempt before class | 9 | | | | |
| No of students who finished atmost one attempt on day of class | 6 | | | | |
| No of students who finished atmost one attempt after class | 0 | | | | |
| 9 students finished before day of class | | | | | |
| 4 students started before class but finished on day of class | | | | | |
| 2 students finished on the day of class | | | | | |
| | | | | | |
| **Total no of students whose attempts are in progress** | 9 | 5 | 1 | **4** | 5 |
| ( all started on 5th october itself) | | | | | |
| 3 students have made 2 attempts > 1 finished (before class) and 1 in progress | | | | | |
| 1 student had attempted quiz, did only single question | | | | | |
| 1 student had attempted quiz but did not attempt single question, but just traversed through the quiz | | | | | |
| 8 students attempted post lunch, 1 student in morning on day of class | | | | | |
| | | | | | |
| **Students who accessed both files for preparation** | 23 | | | | |
| **Access IBCD poster** | | | | | |
| Students who accessed after class | 3 | | | | |
| Students who accessed before or on the day of class | 12 | | | | |
| Students who accessed before and after class | 1 | | | | |
| **Access statistics primer** | | | | | |
| Students who accessed primer after class | 2 | | | | |
| Students who accessed before or on the day of class | 17 | | | | |
| Students who accessed before and after class | 4 | | | | |

Such behavior of skipping the learning objects on the LMS in a flipped classroom is also observed at the other university level for example a degree program in Computer Science from literature (Tangkittipon *et al.*, 2020). This lack of engagement was observed for three consecutive years. To engage the students in learning objects an LMS was introduced but still, the students skipped some learning objects if they were not mandatory (Tangkittipon *et al.*, 2020). Figure 28 shows the student's reasons for skipping the learning objects in the Computer Science degree program. The reasons were the difficulty of technical content; lack of motivation and high workload in FC (Tangkittipon *et al.*, 2020). This example provides similar reasoning of students for skipping the learning objects to the FHNW students in the current case study.

| No. | The Reason for Skipping the LOs |
|---|---|
| 1. | Self-understanding the technical content is too difficult |
| 2. | Lack of motivation waiting for instructor's or classmate's explanation |
| 3. | Course assignments workload is correspondingly heavy |

Figure 28 Reason for skipping the learning objects *(Tangkittipon* et al.*, 2020)*.

### 4.3.3 Student survey for BI class quiz

To understand the above interaction of the students found from Moodle data analysis, I conducted a second more focused anonymous survey with the students who took the flipped lesson in the *Business Intelligence* class on 5th October in the year 2018. For this class, the students had to prepare for the class one week before the 5th of October. The survey was first posted to the students on the 8th of October 2018. The questions in the survey were asked in a way to understand the specific interactions of the students with the learning materials and quizzes on Moodle. The survey questions and answers can be seen in Appendix section 8.1 Following are the main highlights of the survey results: -

1. In the year 2018, nearly 28 students were enrolled in the course "*Business Intelligence*", out of which only 21 (77%) students took the homework quiz from Moodle. Nearly 16 (57%) students took the anonymous student survey about the flipped lesson in October 2018. In the Moodle log analysis mentioned in the section "*Moodle logs analysis of flipped class materials,"* it was found that nearly 23 (82%) students reportedly accessed the preparation materials. It is not possible to know from this Moodle data whether students read through the entire material or not.

2. From question number 2 from the survey, we come to know that nearly 16 students either went entirely OR partially through the preparation materials. Most students referred to the material before the quiz (50%), while some students referred to some parts of the material before the quiz (43.8) and few students read the material in parts while doing the quiz (question number 3). The main reason for not going through the preparation materials was lack of time, while some students knew the concepts from the material from their previous bachelor programs.
3. Some students lacked the motivation to read the materials while some found the material difficult to understand and not sufficient to solve the problems (question number 5). Similarly, the students did not go through the quiz properly i.e., they either skipped some questions, used trial and error methods to randomly answer the questions, or skipped the quiz entirely. The reason for not solving quiz questions properly or by the trial-and-error method was that students felt that many questions in the quiz were complex and did not know the exact steps to solve them. Some felt that they were not motivated to solve the questions, while some were not prepared well for the quiz (question number 10,11). Some students did not take the quiz at all due to lack of time, lack of preparation and motivation, and quiz complexity.
4. In a study analysis of the relationship between motivation and test or quiz performance, it was found that students with high test-taking motivation spent more time solving the test questions and have few skipped or non-answered questions(Liu, Rios and Borden, 2015). While students who spend very little time solving the question (a few seconds) and randomly guessing the answer have low test-taking motivation (Liu, Rios and Borden, 2015). Also, as per the section "*Factors influencing intrinsic motivation,*" we have seen that the complexity of a task has a direct impact on the motivation of students. Tasks that are new and challenging to students can create anxiety in students and diminish intrinsic motivation (Di Domenico and Ryan, 2017). While tasks that are too easy or routine cause boredom in students and diminish intrinsic motivation (Di Domenico and Ryan, 2017). Hence if students did not prepare for the quiz would find the quiz questions too novel and thereby would not be intrinsically motivated to solve them. It is known that optimally challenging tasks promote a feeling of competency among students thereby building intrinsic motivation (M. Ryan and L. Deci, 2000).
5. Optimally challenging tasks are those tasks that can be solved by the student by using his/her current knowledge level or with the (Soltani *et al.*, 2011). Hence the main issue that we observed in the FHNW Business Intelligence flipped lesson is that the students did not find the quiz questions optimally challenging and felt less competent to solve them and thereby either skipped the quiz totally or solved it by random guessing. Furthermore, many students lacked intrinsic motivation or interest to take the quiz properly. The reasons for

finding the questions complex can be that students did not prepare before taking the quiz, they found the material content complex, or they had less background knowledge about the topic.

Figure 29 below summarizes the main themes from the quiz survey conducted above. The green elements represent the themes concerning how students undertake the quiz. The red elements show the reasons for taking the quiz in a particular manner during homework outside of the class. These points are discussed in detail in the previous pages.

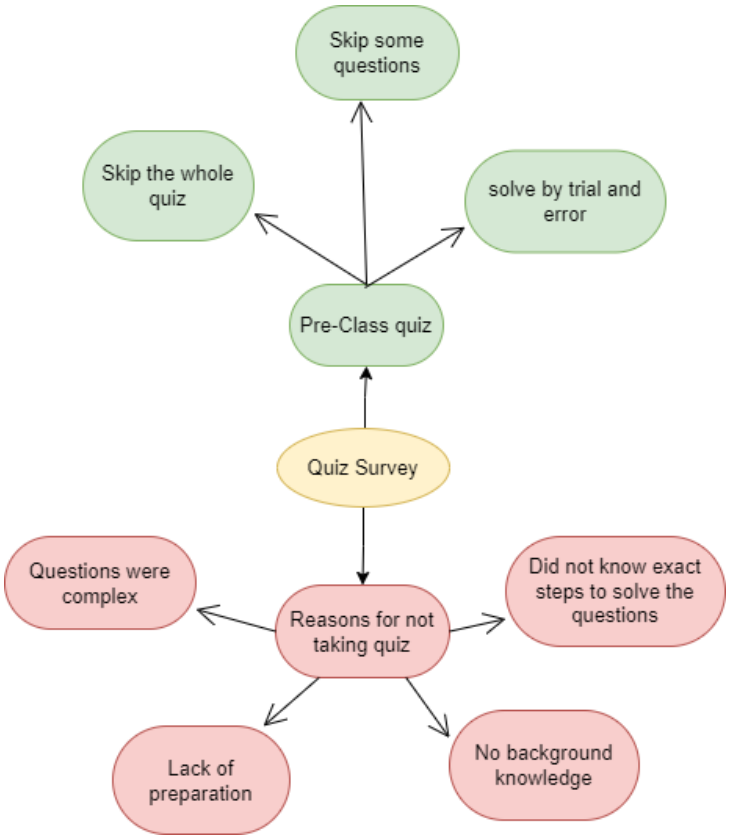



Figure 29 Key themes in the BI class survey

# Chapter 5: Chatbot for increasing student motivation.

The current chapter focuses on the suggestions and the development phase of the design science research methodology. It is seen that the concept of Peer Modeling (PM) produces a feeling of self-efficacy and competency that promotes the feeling of intrinsic motivation in students in section 2.3. Also, the factor of explaining the importance of the learning topic (EILT) explained in the section promotes the feeling of autonomy in students that enhances the feeling of intrinsic motivation in section 2.2. In the literature gap 2.6, it was found that the concepts of PM and EILT are not incorporated in chatbots to build intrinsic motivation among students in the flipped class. There are also no guidelines to use these factors for designing chatbots for building intrinsic motivation. To build intrinsic motivation the thesis develops a chatbot concept that incorporates PM and EILT factors. To design such a chatbot the existing design factors from the literature review proposed by the chatbot and HCI designers (De Vreede, Raghavan and De Vreede, 2021; Yang and Aurisicchio, 2021) are also considered. Once the basic foundational design of the chatbot is prepared the additional design concerning factors PM and EILT are added to the chatbot. Again, for these two factors, pre-existing hints from the literature are considered.

The proposed chatbot is a combination of visual-centric and content-centric interaction styles. In visual-centric chatbot styles, options like buttons with predefined user inputs are given to the end-users (SHNEIDERMAN, 1982; Moore and Arar, 2019). It provides users with a fast option to give input (Moore and Arar, 2019). The chatbot can easily understand the user's intent as the answers are predefined and the chatbot can present the response in less time (Moore and Arar, 2019; Nguyen, Sidorova and Torres, 2022). While visual chatbots present only those visual elements or options relevant to the user's previously selected context and inputs (Nguyen, Sidorova and Torres, 2022). The visual-centric style of conversation is a better choice for FC since students have less time and a high workload. In other styles like the conversational-centric style, the emphasis is more on a human-like natural conversation between chatbots and humans, wherein users ask/type questions in natural language (Moore and Arar, 2019). In such conversational style chatbots, the parsing of the student input relies mostly on the chatbot (Nguyen, Sidorova and Torres, 2022). If the students don't know the intents recognized by the chatbot then they could end up formulating the wrong intent or response (Nguyen, Sidorova and Torres, 2022). The chatbot might not recognize the student's intent and ask for more information or give an error (Nguyen, Sidorova and Torres, 2022). Unpredictable behaviour of the chatbots/agent can lower student confidence and give a feeling of low autonomy and students might stop using the chatbot (Nguyen, Sidorova, and Torres 2022; De Graaf, Allouch, and Van Diik 2017; Lee, Teevan, and de la Chica 2014; Amershi et al. 2019). This is specifically true in the FC context where students are already stressed due to

high workload and lack of time and low motivation levels as seen from the literature review (2.1.2) and the FHNW case study (4). In a content-centric style, the chatbot answers specific answers from the students (Moore and Arar, 2019). Such chatbots' answers are detailed, and the content is designed in collaboration with a subject matter expert (Moore and Arar, 2019). In the proposed chatbot the importance of the learning topics is to be explained to the students hence content-centric style is suitable. Hence the chatbot will be a combination of visual and content-centric conversation styles.

The learning topics explanations and examples of the multi-dimensional modeling (MDM) used in the chatbot are curated with the help of the domain expert, that is the tutor of the Business Intelligence module. The questions asked to the tutor concerning topic content are provided in Appendix 8.2. In the subsequent sub-sections of this chapter, a high-level concept, and functional requirements of the chatbot flow are given. Next, the different screen designs of the prototype are provided along with the explanation in detail. This chapter also contains the generalization and the benefits of the proposed chatbot along with the technical feasibility of the tools used for the development and the proof of concept for a similar peer recommender system.

## 5.1 High-level chatbot concept

The flowchart in Figure 30 describes the chatbot initialization point / its trigger, the main menu of the chatbot along with the intermediate steps/options of the navigation until the user quits the chatbot system. Every option and its corresponding result in the chatbot are designed to support the three emotional needs of autonomy, relatedness, and competency (ARC) among the students that build intrinsic motivation. The goal of the chatbot is to build intrinsic motivation among flipped-class students concerning the learning topic. Also, here the students should be interested in using the chatbot for getting an overview of the learning topic.

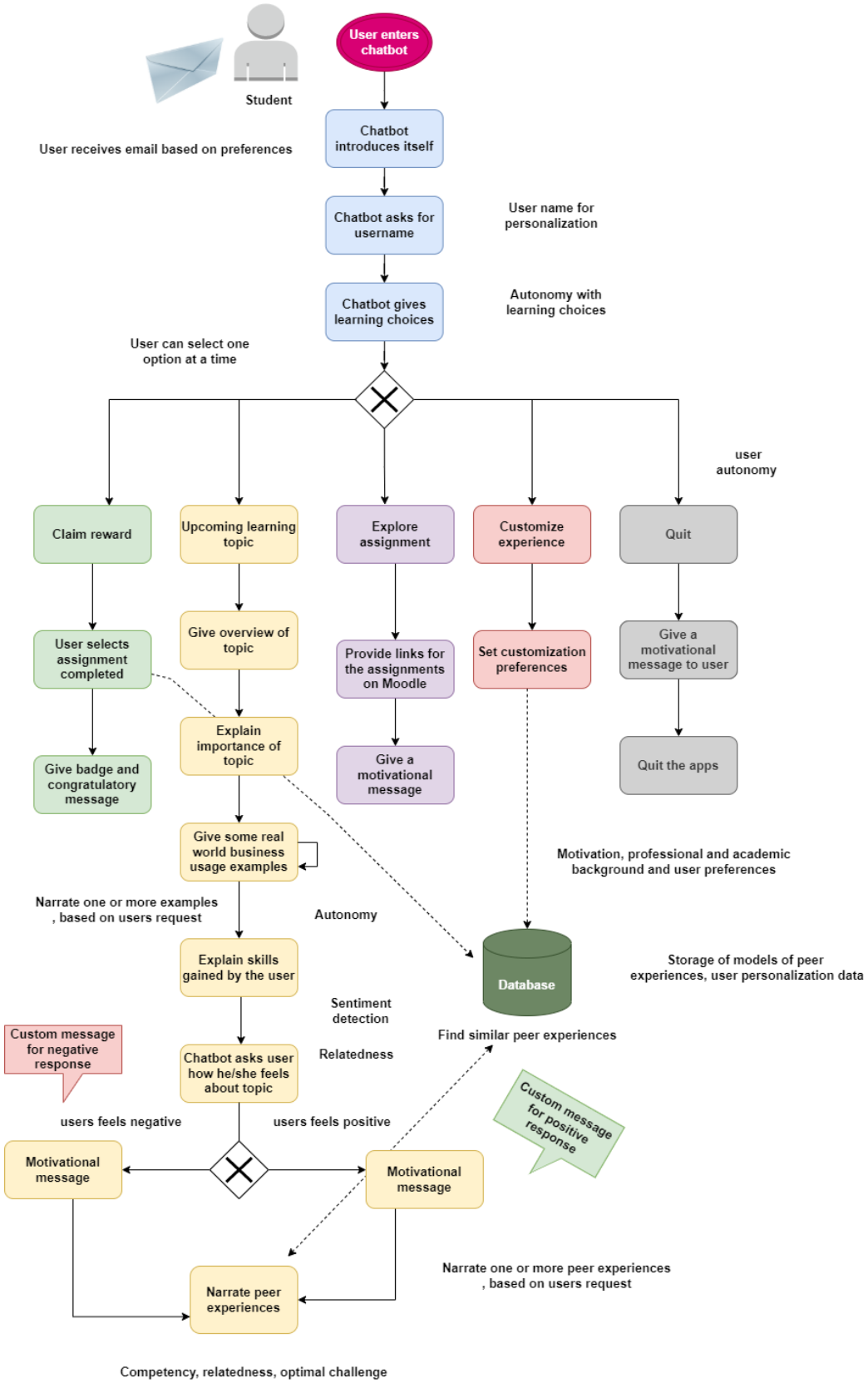



Figure 30 Flowchart of the proposed chatbot

### 5.1.1 Main menu of the chatbot

The chatbot link will initially be provided to the students via email by the tutor a few days before the flipped lesson. When a student enters the chatbot interface for the first time the chatbot will ask for the username. This username will be used in the conversations further to give a personalized touch. After that, the chatbot will introduce its capabilities. It gives a high-level overview of what functions it provides to the end user. As per (Yang and Aurisicchio, 2021) it is a good practice to introduce the capabilities of the chatbot/CA within the conversations rather than learning it from outside (Yang and Aurisicchio, 2021). As we have seen this sets the student expectations from the chatbot and encourages them to use the chatbot/CA effectively (Yang and Aurisicchio, 2021). After its quick introduction, the proposed chatbot gives options to the student in the form of input buttons with predefined options. These options define the main menu and the main features of the proposed chatbot. A student can select any button he/she wants and explore that option without any constraint of freedom The main menu given has the following options: -

- Next week's learning topic
- Claim a reward for the completed assignments.
- Explore assignments.
- Customize experience.
- Quit

The elements for the chatbot initialization, self-introduction, and username input are shown in light blue colour in Figure 30. Table 4 below shows the different features of the chatbot mapped to the ARC needs of students in this sub-section.

| Chatbot Feature | Emotional needs of students | Explanation |
|---|---|---|
| The chatbot refers to itself as "I" and uses the name of the student in the conversation | Student **relatedness** with the chatbot | It is observed that a feeling of relatedness is promoted in users when the chatbot mentions itself as "I" and uses the name of the students in the conversations (De Vreede, Raghavan and De Vreede, 2021). |
| The chatbot introduces its capabilities and features | Student **competency** concerning the use of the chatbot | By knowing what the chatbot is capable to do students themselves will feel competent to use it (Yang and Aurisicchio, 2021). |
| The chatbot gives options to students in the form of buttons to choose the different menu options related to the learning topic MDM. | Student **autonomy** concerning the exploration of the learning topic via the chatbot | By giving choices to the students of exploring the learning topic the chatbot gives the feeling of autonomy to students. We know that autonomy is the freedom that is given to students so that it allows them to do learning/study at their own pace and choice (Trenshaw *et al.*, 2016).<br>A learning system must be built to increase student autonomy because if user autonomy increases then it also increases perceived competency and as a result, it increases performance and system satisfaction (Nguyen, Sidorova and Torres, 2022). |

Table 4: Mapping of chatbot features to students' emotional (ARC) needs – part 1.

Researchers in their experiments have suggested that chatbot environments that provide autonomy, relatedness, and competency conditions while interaction with the user increase the user's satisfaction and engagement with the chatbot system (Nguyen and Sidorova, 2018; De Vreede, Raghavan and De Vreede, 2021). Hence in the features of the Flippy chatbot, the thesis includes some of the designs recommended by these researchers.

### 5.1.2 Topic importance and peer modeling delivery

The chatbot option "*next week's learning topic*" narrates the importance of the learning topic to the student. At first, the chatbot gives a basic introduction about the learning topic with a few examples of how the topic helps in the practical context in a generic way. Then later the peer models will give exact examples of how the topic helped them in their specific projects or assignments. The reason for this sequence is to give a general idea about the topic to the students initially so that when they come to the peer experiences, they already have some basic understanding of the topic. The importance is divided into different small sub-paragraphs containing different sub-topics and examples to not overload the students with a lot of content. For navigating to different paragraphs students are provided with the continue buttons along with appropriate captions which will be described in further sections in detail. Students can also navigate back to the main menu and select other options. The flow for EILT and PM factors is shown by the subtree with yellow elements in Figure 30. The upcoming learning topic option is divided into the following subparagraphs: -

a) In the first paragraph, the chatbot introduces the main objective of the topic and gives a short overview. A short highlight or an introduction about the topic is given along with an example and a related image.
b) The user is then provided a continue button so he/she can continue with the next paragraph. The continue button has a small message in the brackets which tells the user what they will expect in the next paragraph. For example, continue (Understand the importance of MDM). Please click Figure 34 for an example of the continue button. In the next paragraph, how the topic solves business problems and helps stakeholders achieve their goals is explained in short.
c) After this, real-world examples concerning the topic will be provided to the students. These examples are explained generically by the chatbot itself. Giving real-world usage examples of concepts is highly motivating and inspiring to students if the task is impacting them, society, or the company in a positive way or has a positive outcome on society (Hewlett, 2009; Pink, 2009). Later during the chat, the peer models will also give a few examples of how the learning topic helped them in their professional life. After giving examples, the chatbot will then explain to the students what skills and knowledge they will gain when they learn that topic well.
d) After this stage, the chatbot will ask students about their opinion about the learning topic. If the students' answer is positive for example, they felt interested then the chatbot sends a custom positive motivational message. If students' response is negative for example if they felt anxious, then the chatbot will send them a custom motivational message. Sentiment analysis technology from Natural language processing is usually used to detect the positive and negative sentiments from the text conversations of the user (Borisov,

2018; Veglis and Maniou, 2019). In both custom messages, the chatbot asks the students whether they would like to hear the learning experiences of students concerning the current topic.

e) Next, students are delivered peer modeling experiences by showing videos of past students' experiences and by narrating the experiences of individual students (Bandura, 1997; Murphey and Arao, 2001; Belland, Kim and Hannafin, 2013). The peer model narrations will contain: -
   - ✓ *The background and knowledge level of students and how students prepared for the flipped class; what challenges they faced during the preparations, and how they overcame them.*
   - ✓ *How students used the MDM concepts to solve a problem in their organizational processes and projects and how it positively impacted the respective stakeholders.*
   - ✓ *Student experiences on how the MDM topic helped them in their professional and academic growth. For example, they got a new role or a client project that made a positive impact on the organization and society. Another example will be how students used the topic for their projects in the Business Intelligence Class.*

f) The student similarity is relevant in the FC context and is connected to the educational and professional background of the students (Murphey, 1996, 1998, 1999, 2003; Murphey and Arao, 2001; Muir, 2018). For finding similar peers for narrating peer experiences, the proposed chatbot considers similarity factors of the students based on the educational degree (bachelor's degree), professional level based on years of experience (fresher, intermediate-level, and executive), job role (for an example software developer), the workload of job (part-time, full time). These similarity factors are discussed in detail in section 5.5.

g) Students are given an option (button) by the chatbot to know the experiences of more than one peer model hence providing them autonomy. We know from the literature review that if students are given exposure to more than one peer model then the chances of them getting motivated are high (Thelen *et al.*, 1979; Bandura, 1986; Schunk, 1987). Table 5 below shows the different features of the chatbot mapped to the ARC needs of students in this sub-section

| Chatbot Feature | Student emotional needs | Explanation |
|---|---|---|
| The chatbot asks the students how they feel during topic exploration | Student **relatedness** with the chatbot | This feature aims to create a feeling of relatedness among students and to motivate them. We have seen in the literature that chatbots provide emotional support to mental health issues patients by detecting their mood swings during conversations (Singh, 2017; Wysa, 2022) |
| The chatbot introduces similar peer video and text experiences concerning the learning topic to the students. | Student **competency** related to the learning topic. Students feeling **related** to the similar peer | By seeing other similar students doing impactful work and making a positive difference in their professional and academic life the students will get inspired and motivated to learn the topic and do preparation for the flipped class. We have seen from the literature review that students' feelings of self-efficacy and competency for a task or activity are built when they see similarly abled students succeed at the same task (Bandura, 1995; Zimmerman, 2000; Schunk and Pajares, 2002).<br>When the students see a similar peer struggling with a task and then later succeeding in the task, then they would also feel inspired and connected to the student at an emotional level (relatedness) (Schunk, 1987; Kichiji, 1997; Murphey and Arao, 2001). The students will think that the task is doable by giving persistent efforts. |
| The chatbot explains the significance of the topic (examples, skills gained, etc.) | Student **autonomy** concerning the study of the learning topic | As per the theory Organismic Integration Theory (OIT), even if students are not interested in learning, if they understand the values of certain activities as important for their learning, they can make them a part of their learning habit or process by self-choice (M. Ryan and L. Deci, 2000). When such a person regulates learning by integrating new values his/her learning becomes autonomous and self / regulated (M. Ryan and L. Deci, 2000). Motivation researchers (Kusurkar, Croiset and Ten Cate, 2011) also mention that a teacher should explain the importance of non-interesting topics to students so that they understand their value and choose to study them autonomously rather than under pressure. Here the chatbot does the role of explaining the importance of the topic to the students. |
| The topic explanation is broken down into different paragraphs by the chatbot. Buttons are provided for students to continue or exit the option. | Student **autonomy** concerning the exploration of the importance of the learning topic | The proposed chatbot uses different paragraphs containing the importance of the learning topic/objective. It provides buttons to navigate the different paragraphs. Conversational UX designers (Moore and Arar, 2019) recommend dividing the long content into smaller paragraphs so that users can navigate to the details they desire. This feature provides autonomy to students to read or skip any content of the learning topic as per their preference. |
| The chatbot uses the images in the learning content to explain some concepts. | Student interest and fun concerning the learning content. | The use of pictures, images, and videos in chatbot interactions creates elements of fun and interest to capture the attention of users (Kowald and Bruns, 2020; Senevirathne and Vidanagama, 2020). |

Table 5: Mapping of chatbot features to students' emotional (ARC) needs – part 2.

### 5.1.3 Supportive functionality

After the student completes the peer modeling experiences, the chatbot provides the students the links to the assignment materials. Again, this is optional and autonomous, and the button will be provided so that the user will be able to click and see the materials on the topic. Also, the button option for the exploration of preparation materials is present at every level of topic exploration and students can check out the assignments any time they want. This option is also present in the main menu of the chatbot at the start. The chatbot only tells the student what they need to prepare and the types of assignments. It does not tell them if it's mandatory or not and doesn't enforce the assignments on them. Any form of control like for example keeping assignments mandatory undermines intrinsic motivation (M. Ryan and L. Deci, 2000). The elements for the assignment options are shown in purple colour in the flowchart in Figure 30.

Another important option in the main menu of the chatbot is the "*Claim a reward for assignment*". To keep the interest of the students engaged with the tool, when students interact with the learning topics/goals of that week and complete the required preparation, they will be given a mastery reward like a karate belt. Please note that this reward is not tangible but is given to motivate students by giving their acquired knowledge level. Please look at the explanation in Table 6. For example, white, orange, blue, yellow, green, brown, and black indicate further progress at different weeks. When the students complete the learning assignments on their own, they can come back to the chatbot and update their progress book where they will select the activities they completed, and they will immediately get a reward for that level along with a motivational message. For example: "*Congratulations John, you have acquired a white belt in this module. This will allow you to identify the correct data sources for your business process which is a foundation for your data modeling… Well done!!"* At the end of the learning goals of the whole module, the student will be given a black belt and a congratulatory message that they have completed the module learning goals and are now an expert. The elements for the reward options are shown in green colour in the flowchart in Figure 30.

Another option that the chatbot provides in the main menu is to customize the experience of the chatbot. Students can set their preferences for getting a custom personalized experience. The chatbot will allow the student to set their educational and background data like bachelor's degree, job role, professional experience level, and workload. When these values are set, then the students get peer model recommendations like their academic and professional profiles. It is evident from the FHNW student surveys that students take the lessons for different motivations i.e., either for interest in the topics or for professional growth, or academic growth. Based on their motivations chatbot will recommend different peer model experiences.

For example, if the student selects his/her motivational orientation as professional growth then a peer model where the peer used the learning topic knowledge for professional growth will be recommended during interaction with the chatbot. While gathering the student preferences the chatbot reveals where and what data is used in the chatbot. Also, it will take consent from the student to use the data for personalization of the user experience. The elements for the customization options are shown in red colour in the flowchart in Figure 30. The last option in the chatbot's main menu is the quit option. When the user selects this option the chatbot will send a motivational message to the student and the session will end. Table 6 on the next page gives the features of the chatbot in this section and the ARC needs that they promote and its explanation.

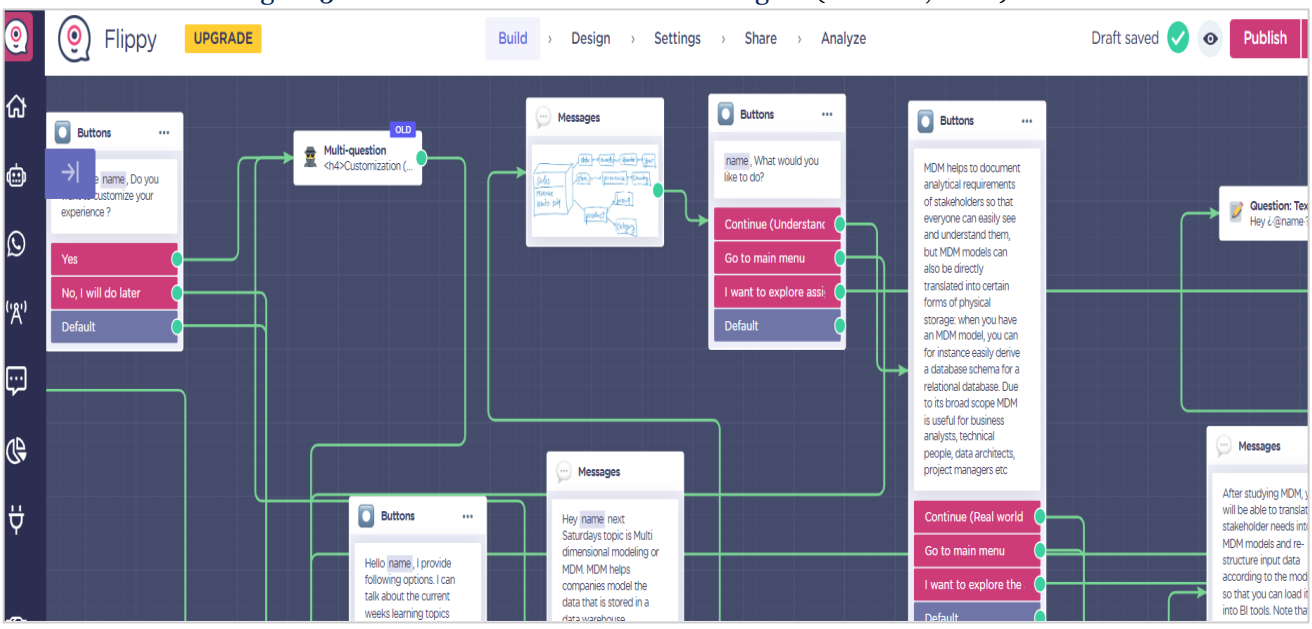
| Chatbot Feature | Student emotional needs | Explanation |
|---|---|---|
| The chatbot provides buttons at every level of the menu to explore assignments. | Student **autonomy** concerning the exploration of the learning assignment | Freedom is provided to students to explore the assignment at their own pace and choice. |
| The chatbot provides the students with a record of their current mastery level and provides congratulatory and motivational messages at the end of their learning assignment. | Student **competency** related to the learning topic | Positive constructive feedback to students about their progress builds competency and enhances intrinsic motivation (Deci, Koestner and Ryan, 2001; Niemiec and Ryan, 2009). As per intrinsic motivation, experts giving tangible rewards like bonus points at the start of the activity undermines intrinsic motivation (M. Ryan and L. Deci, 2000). Tangible rewards can be money, prize, or tokens and are physical (Carton, 1996).<br>The belts awarded by the chatbot after the successful completion of the learning topic assignments to the students are *not tangible rewards* and only convey the knowledge level of the student and congratulatory messages. Giving positive feedback with meaningful information about the work or task outcome can impact the intrinsic motivation of users positively (T. M Amabile, 1996; Deci, Koestner and Ryan, 2001; Pink, 2009). The feedback can be about the strategy and efforts required for task completion (T. M Amabile, 1996; Deci, Koestner and Ryan, 2001; Pink, 2009). The mastery level or the specific belt provides information to students as to what skills they have mastered after completion of the learning topic assignment. Also, congratulatory messages are given to motivate students to perform well in the next learning topic. Giving praise or a motivational message at the end of an activity only builds intrinsic motivation (Deci, Koestner and Ryan, 2001; Pink, 2009). |
| The chatbot provides user customization settings for personalizing user experiences for peer modeling. | Student **autonomy** with the data used in chatbot | The researchers (Yang and Aurisicchio, 2021) in their design guidelines suggest that user personalization promotes a feeling of autonomy in students. In addition, telling the users how and where their data is used and giving control over their data also promotes trust and autonomy feelings among students (Yang and Aurisicchio, 2021). |

Table 6 Mapping of chatbot features to students' emotional (ARC) needs – part 3.

## 5.2 Screen designs of the proposed chatbot

Based on the conceptual design of the chatbot in the previous section, a detailed design of the chatbot is presented in this section. To test the design of the concept in actual settings of the flipped class, a proof of concept is developed. A proof of concept (POC) is a model or a demo to test whether the proposal, plan, or solution is efficient or feasible to be developed into a full-fledged product or application (Sánchez-Villarín *et al.*, 2020). The proof of concept for the proposed chatbot is developed initially for students of the Business intelligence module in the flipped lesson on **Multidimensional modeling**. The reason for selecting the topic is because of its fundamental nature in the Business Intelligence module. The concepts from this topic are used in business organizations to create data models, extract meaningful information from the processes, and visualize reports for decision-making. This topic has a significant impact on different stakeholders in business organizations. Hence, the topic would be an ideal example for the POC demonstration. The content of the topic explanation and examples were developed in collaboration with the tutor of the Business Intelligence module. The peer modeling content was developed by conducting student interviews. Prior consent for the peer modeling narrations was taken during the student interviews. The questions asked in the interviews and the examples of the peer model narrations are given in Appendix section 8.3.
To design and simulate the chatbot an online tool called LandBot [7] is used. Landbot provides tools like designer tools with visual elements to design and automate chatbots (Landbot, 2022). Figure 31 below shows the Landbot designer that provides tools to design the workflow/business rules for the chatbot and decide the visual elements like buttons and the content of the chat conversations.

Figure 31 Landbot workflow and screen designer (Landbot, 2022)




[7] https://landbot.io/

Following are the figures below for the student chatbot interaction screens from the Landbot tool: -

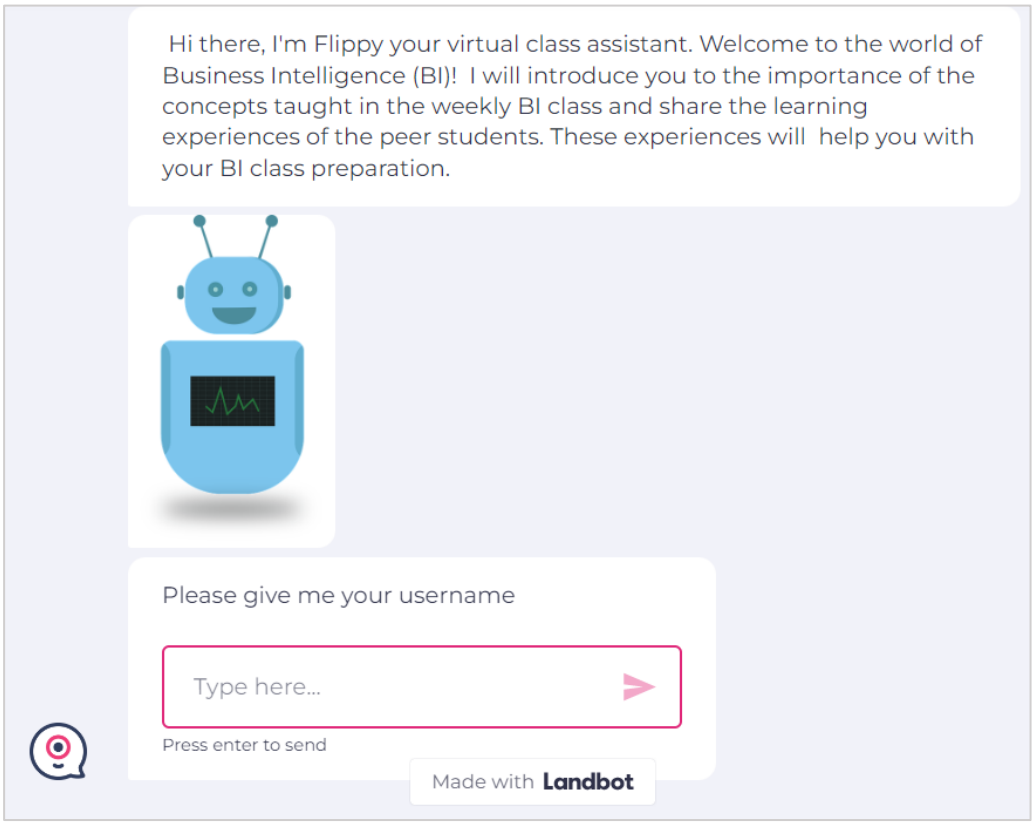



Figure 32 Flippy chatbot username input

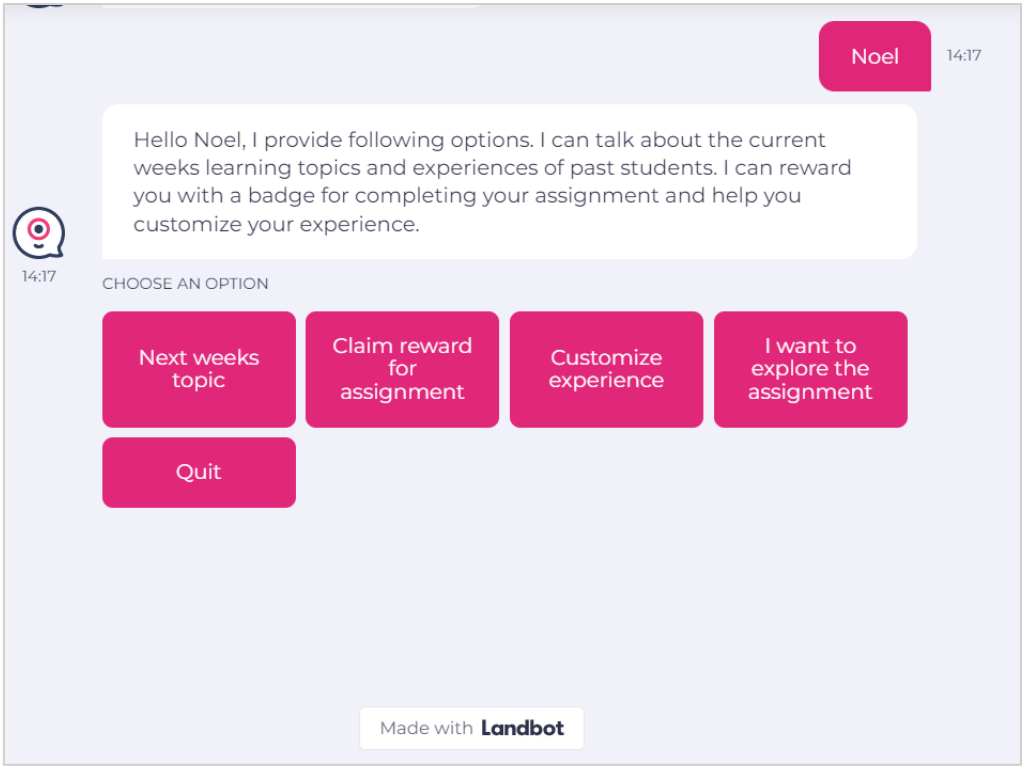



Figure 33 Flippy chatbot main menu

a) In Figure 32, Flippy the chatbot introduces itself by its name and its capabilities along with its picture. Chatbot designers recommend having a particular personality for the chatbot like a name, image, and how they converse with the users, especially their tone (Acquire, 2021). By giving an image of the chatbot the students come to know that they are chatting with a virtual assistant and not a real human. It then asks for the username of the user. This name is stored in the session and used in the interactions further. Next, the chatbot Flippy presents its specific capabilities and provides buttons to select the following features: next week or the upcoming topic, claim the reward for the assignments completed, explore the assignment, customize the experience, and quit. By providing button options it provides autonomy to students to select their course of exploration as per their choice. Please refer to Figure 33. This is the main menu of the chatbot which highlights the main functionalities. When the student clicks on a particular button of choice, the chatbot takes the student to that topic. Chatbot designers suggest having a main menu at the start of the chatbot (Valério *et al.*, 2017). This menu is buttons that are quick replies. This main menu decides the main course of action for user explorations. The use of the main menu is to give the student the ability to make a quick decision and to receive the outcome immediately.

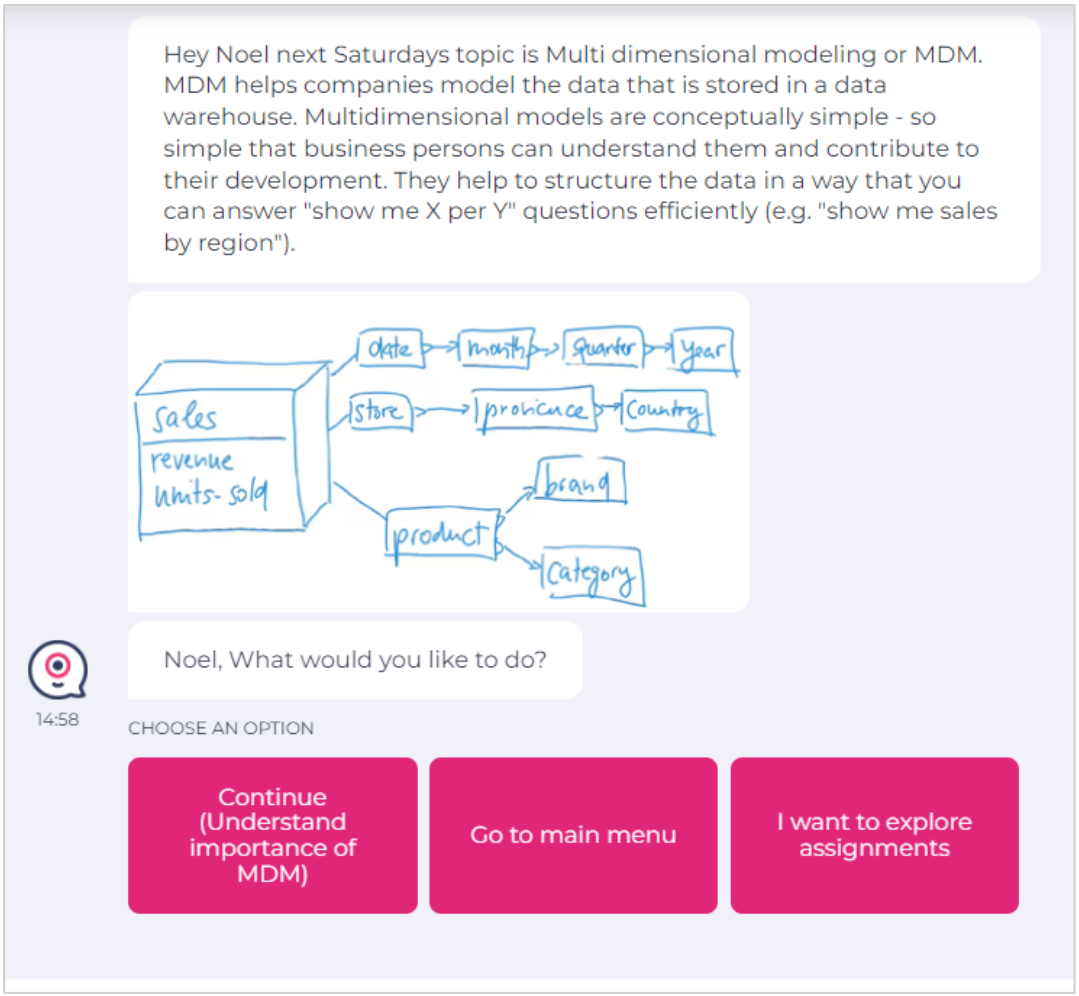



Figure 34 Flippy chatbot introduction to the learning topic

b) In Figure 34, the user selects the next week's learning topic, then the chatbot explains the high-level overview of the multidimensional modeling (MDM) topic by giving an example. The concept is made clear by providing an image of the example. Instead of directly explaining the importance of the MDM topic, at first, the topic is explained by giving an example. The content is informative and concise. Next, the user is prompted for the next action set of continuing with the importance of the coming topic, going to the main menu, or wanting to explore the assignment.

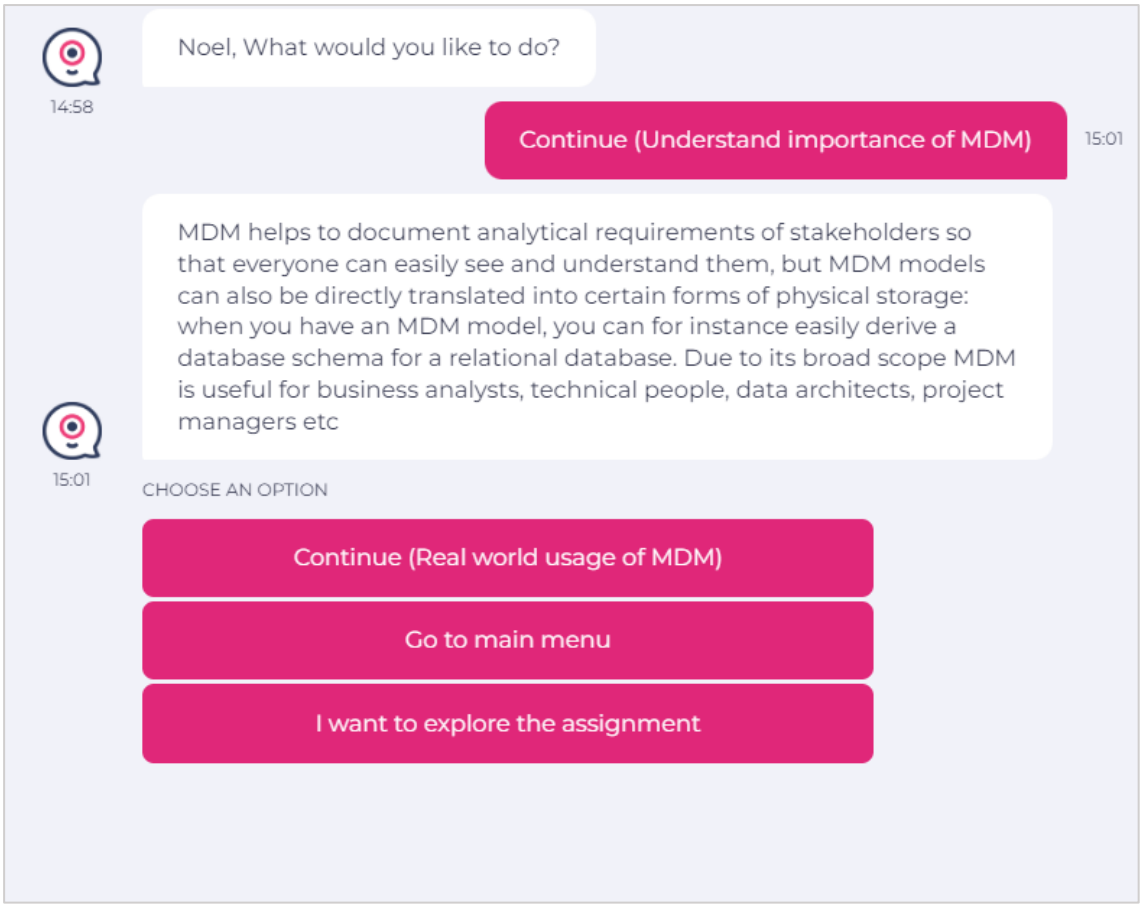



Figure 35 Flippy chatbot importance of the topic

c) If the user selects the continue with importance option, then the importance of the MDM topic is explained. Please refer to Figure 35. The importance of the topic concerns different stakeholders and how it helps them to do their business tasks in a better way. Multi-dimensional modeling is a broad topic, and it helps different stakeholders hence all the stakeholders are mentioned in importance. Again, the student can select to continue with real-world examples of MDM or go to the main menu or explore the assignment. If the student selects the example option, then an example of how a stakeholder namely a sales manager uses MDM to solve his/her information needs for data analysis is explained in short. The student can also see more examples by clicking on the button to explore more real word examples button. Now only one real-world example is given to students to keep the design simple. Also, the main aim is not to confuse students with a lot of examples, but first to familiarize them with the basic idea of the chatbot app. Another option given is to continue with the skills gained along with the main menu and assignment options. Please refer to Figure 36.

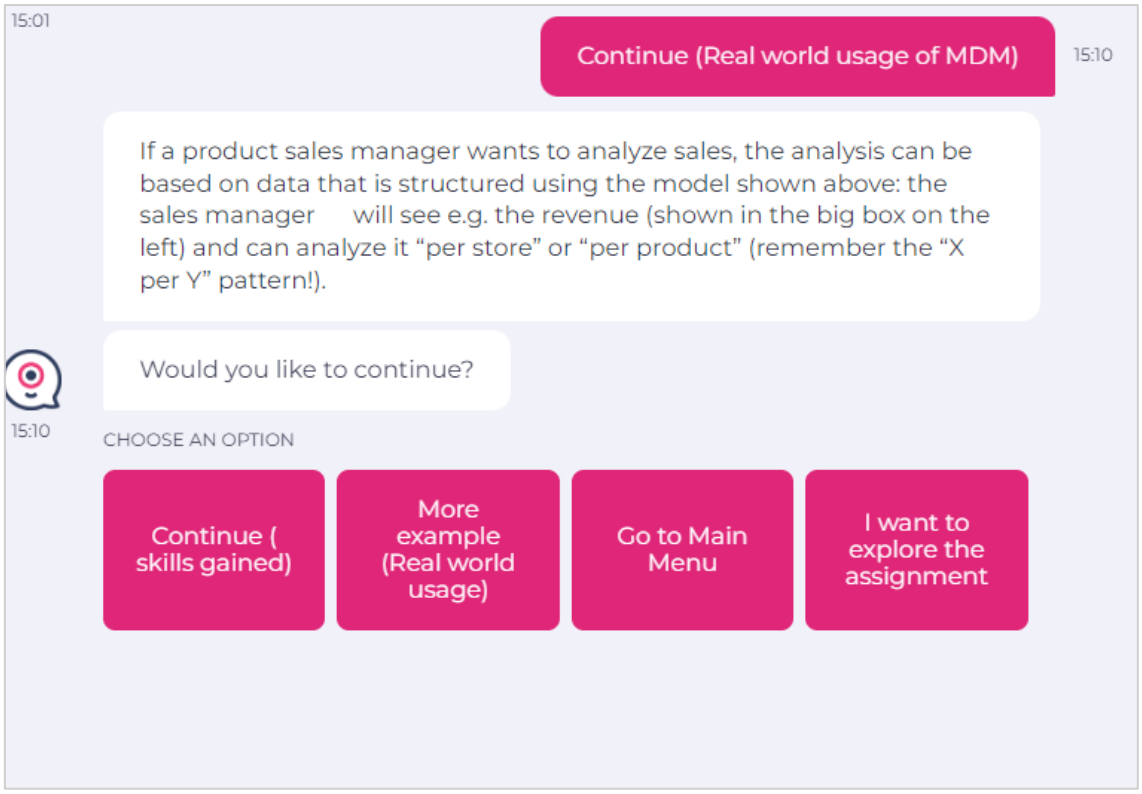



Figure 36 Flippy chatbot real-world learning topic usage example

d) To allow students to make informed decisions to continue with the next options, the continue button is provided with a short title that conveys what content will be shown in the next chatbot response. To avoid information overload, a short title for the continue button is given in brackets for example Continue (skills gained). Alternatively, to make it more informative a tooltip on the continue button hover could also be provided. This tooltip will give a short highlight of the next paragraph delivered by the chatbot. Currently, the tooltip feature is not available in Landbot.

e) If the student clicks on it to continue with the skills gained, the chatbot explains to the student what skills he/she will gain by learning this topic, what problems they could solve, and what tools they would be able to use to solve the business problems as multidimensional modeling is a highly technical topic. Please refer to Figure 37. After this, the chatbot asks the opinion of the students on how he/she feels about the topic. Here the chatbot will use the sentiment analysis technique to understand if the input word is positive or negative. If it is negative, then the chatbot gives a positive message to boost the confidence of the student. For example, if a student replies as anxious then Flippy will reply "*Hey Noel, I know that you feel anxious. But don't worry I am here to motivate you through the experiences of past students. Their experience conveys how the MDM topic helped them in their academic and professional life. Are you interested to check out?*". If it's a positive reply by the user, then it will reply as given in Figure 38. Now the sentiment

analysis technique is simulated in the chatbot as this is not the scope of the chatbot.

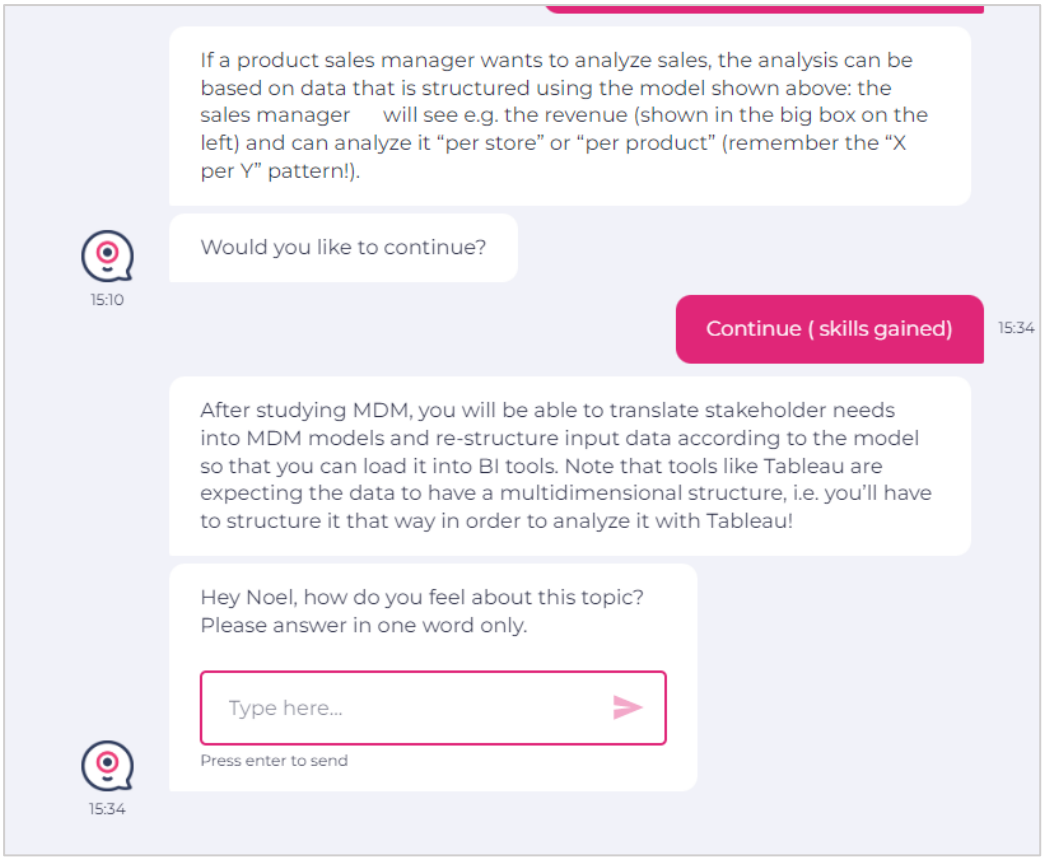



Figure 37 Flippy chatbot skills gained.

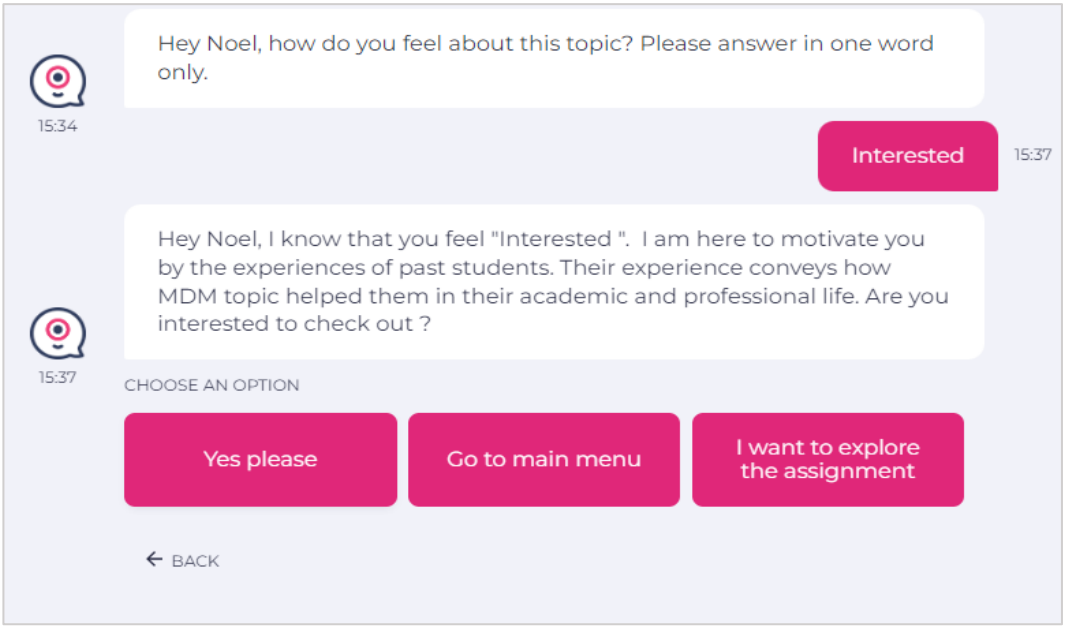



Figure 38 Flippy chatbot sentiment check

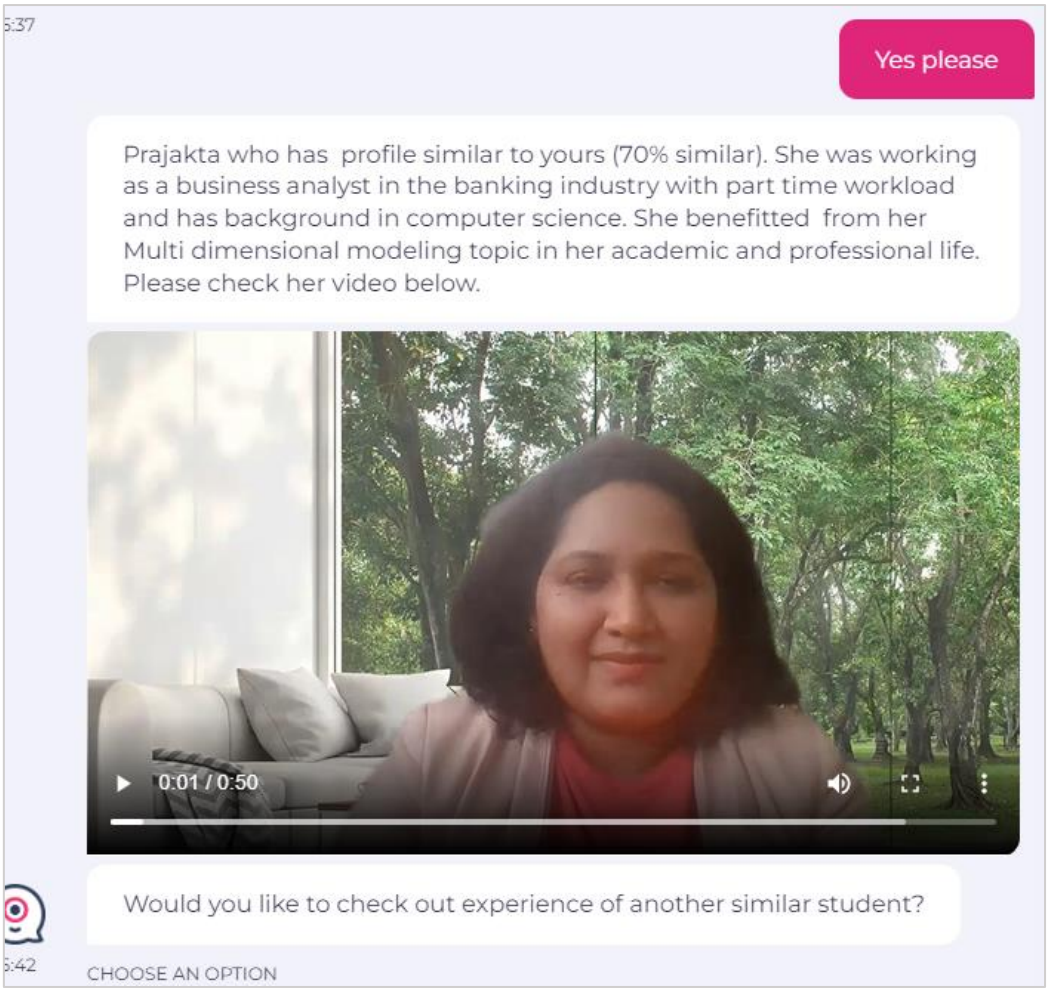



Figure 39 Flippy chatbot with peer model example with video

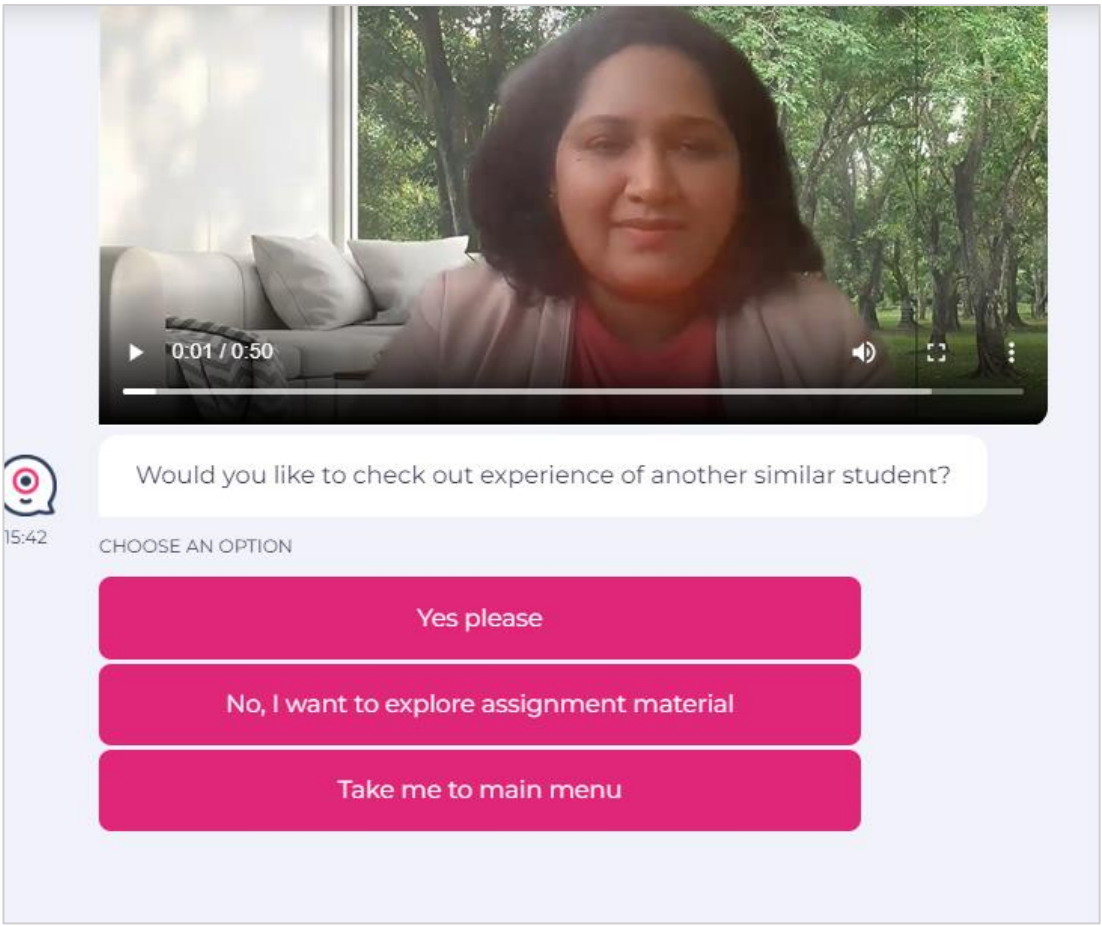



Figure 40 Flippy chatbot peer model with button options

f) If the student says yes, please then the peer model and its educational and professional background are described. Please refer to Figure 40. A video is shown where the peer model describes its experience with the MDM topic and how that topic helped in its professional assignments at work and its impact. In the introduction, the similarity of the student's profile with the current student's profile in percentage is also given along with the attributes for example educational background, job role, and workload. The current example of the peer model with the similarity percentage is a simulation. This value is hardcoded to give users a feeling about the near-peer experience and how similar peer experiences would be delivered via the chatbot.

g) The student is given an option button to explore more examples of similar peer models. If the student clicks on “Yes please”, then the student is navigated to the experience of another peer. Please refer to Figure 41. At the end of the experience, the students are asked if they would like to go to the assignment for that topic. For the proof of concept, two examples of the peer model are shown. The reason for providing such examples is not to overwhelm the students with too many examples at the start. In the future, functionality to view more peer examples can be provided. The peer model data is obtained by

interviewing students. The interview questions as well as some more peer model narrations are provided in Appendix 8.2.

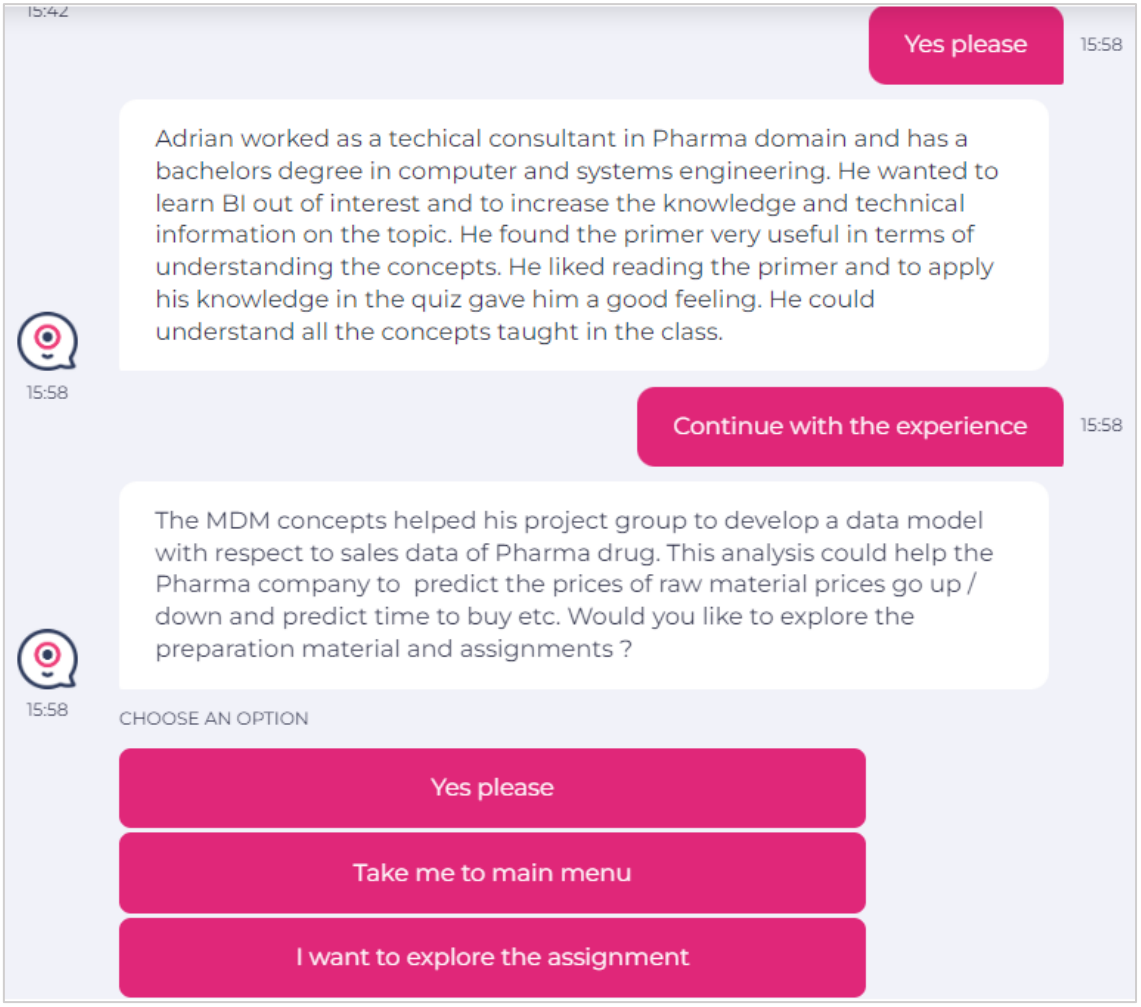



Figure 41 Flippy chatbot peer model experience with button options

h) If the student says yes, please, then the chatbot explains the assignment materials which need to be prepared by students and they can take multiple attempts of the assignment if it's a quiz. The links to the material to be prepared are also provided. After this, the student can either go to the main menu or quit the application. A motivational message for example "I am sure you would do well. All the best" is also given at the end to motivate students to complete the assignment. At this moment if the student is interested to learn more about the topic in detail, then he/she would go to the links and read the materials and prepare well. The links and the assignment are independent of the chatbot and reside in the learning management system. Please refer to Figure 42 for the assignment.

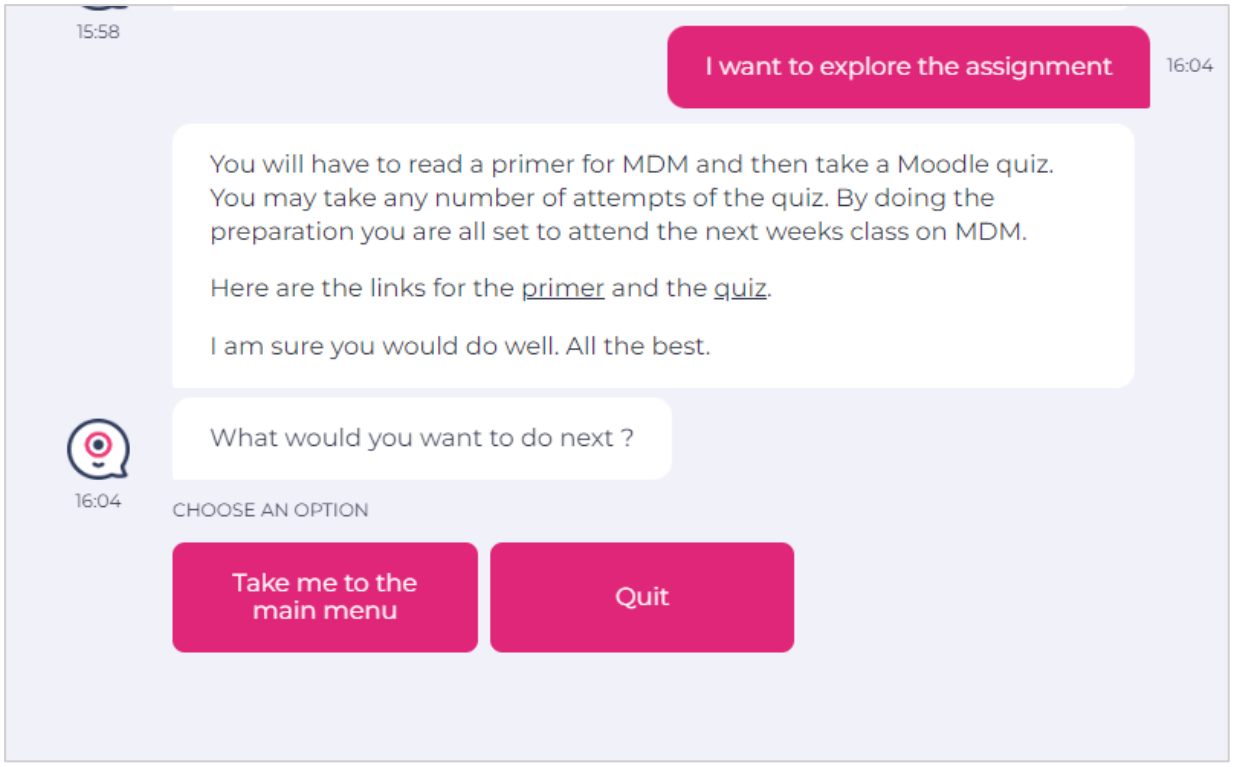



Figure 42 Flippy chatbot assignment option

i) In the claim rewards section, students can select the latest assignments completed and then get a reward/badge for the completed level in the Business Intelligence module. The badge corresponds to the mastery level in that topic and is based on the colours of the karate belt. Along with the badge, there is also a motivational image to motivate students to complete more assignments. The chatbot also explains in one-line what skills the student gains for that topic and what he can do with those skills. The reward is given for past completed assignments. For example, please check Figure 43, and Figure 44. Here again, the badges for three previous assignments before the showcased MDM topic are given.

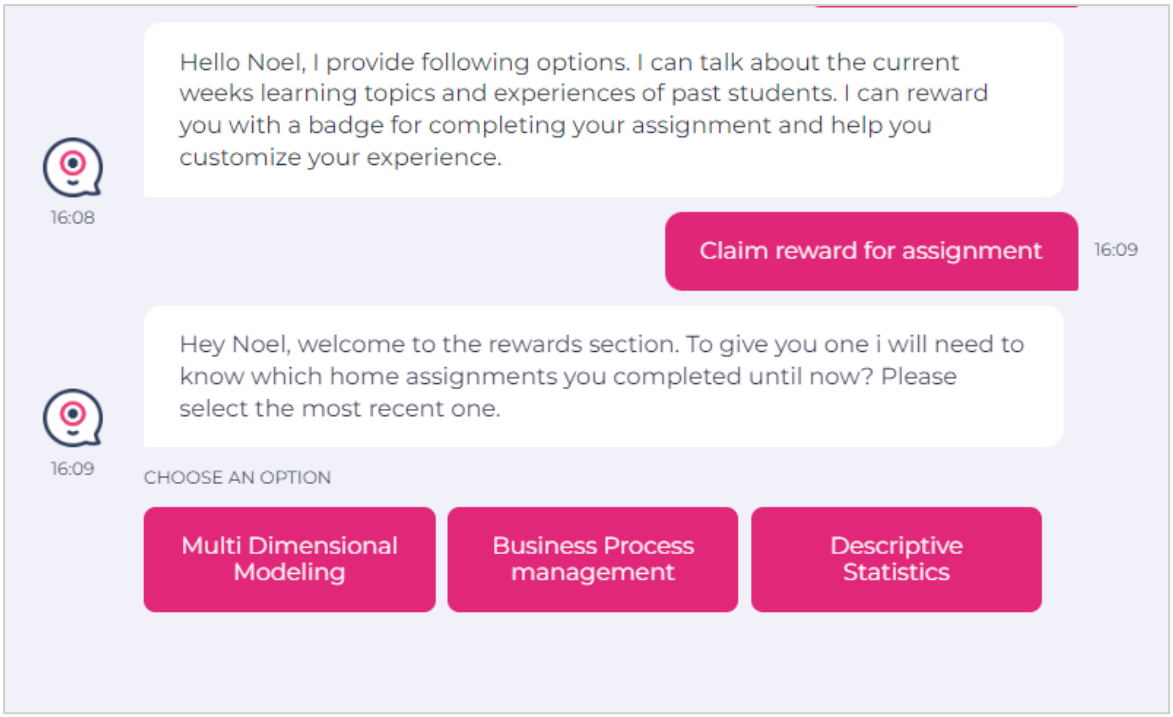



Figure 43 Flippy chatbot claim reward option.

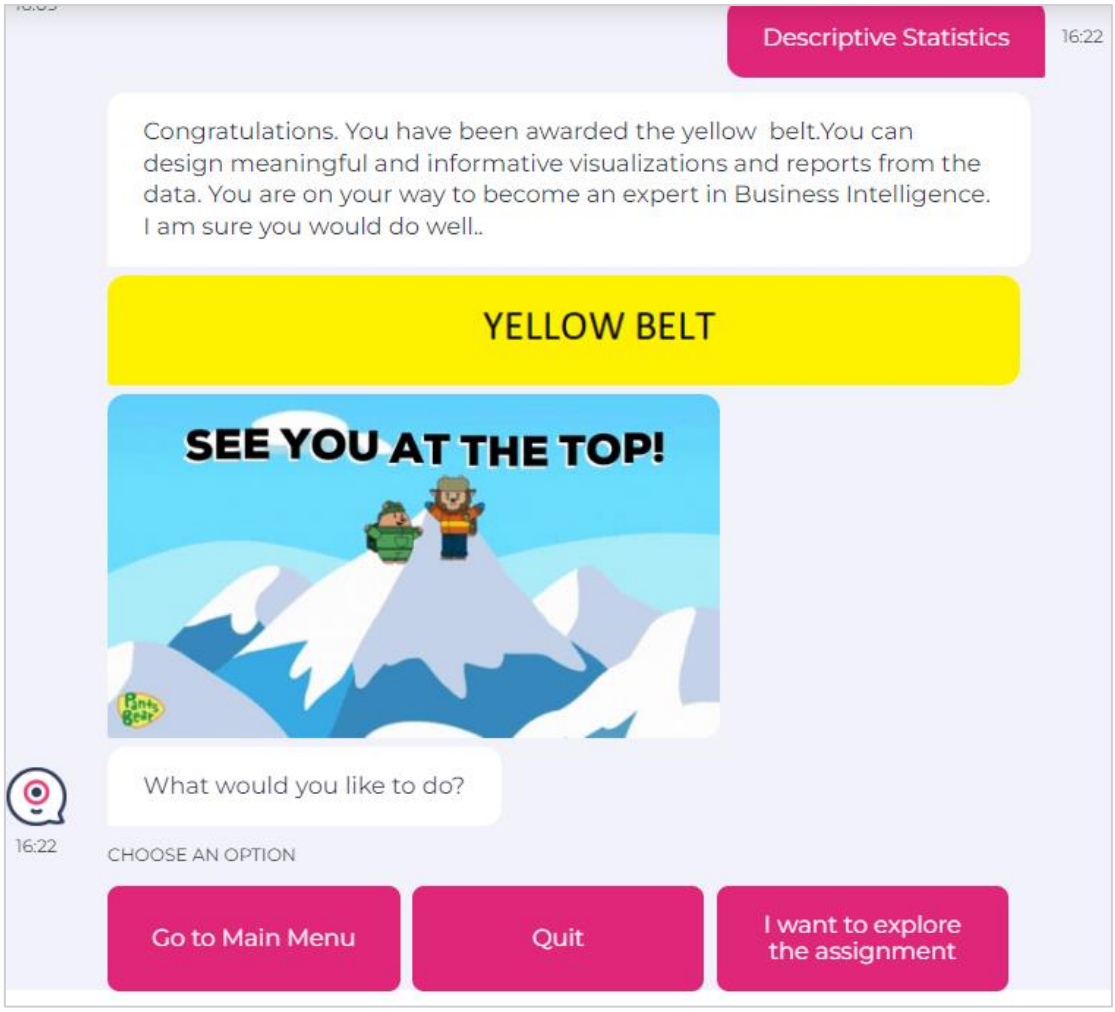



Figure 44 Flippy chatbot reward for the completed assignment

j) The customization option from the main menu allows students to set their personal information like bachelor's degree, professional level (entry-level, intermediate level/managerial, executive) based on years of experience, and responsibility level. Students can set their workload type as part-time students or full-time students and the role of the students in their job. They also can set their motivation for doing their Business Intelligence module. For example, their motivation can be to achieve grades (academic), professional growth, or to increase their knowledge or interest in the topics. They can also set whether they want to get reminders for upcoming assignments in their email. If set, then the chatbot will send them an email with the link to the chatbot to explain the upcoming topic. Based on these settings peer experiences of similar students will be narrated to students. Also, if their motivation is for professional growth then peer model stories where they used MDM topics for their professional growth will be narrated. Students are informed of how their data will be used and saved and their consent will be taken and then only the data will be saved in the database. If these settings are not set, then the chatbot will not show any customized recommendations but rather will show the

experiences of all peers for that topic. It is not mandatory to set these values for the customization settings and students who don't feel comfortable can skip them.

k) The customization setting is a form that is shown where students could select values from visual elements like dropdowns or select options to fill and enter values. The values for the job roles and bachelor's degrees are taken from the student surveys. The module Business Intelligence is taken by students from a variety of computer and business backgrounds and engineering and management backgrounds. Also, many students work in different industries like banking, pharma, IT or high tech, and consulting and have roles like business analysts, project managers, developers, consultants, and engineers. Moreover, the students come from different professional levels based on years of experience and job responsibilities like fresher, manager, and executive. Some students study part-time while some study full-time. The data found from these surveys is used in the drop-down and the radio button values. In the proof of concept made in Landbot, the customization form is only shown for demonstrating the idea and is not yet implemented in the system. Figure 45, and Figure 46 for the input forms are given on the next pages.

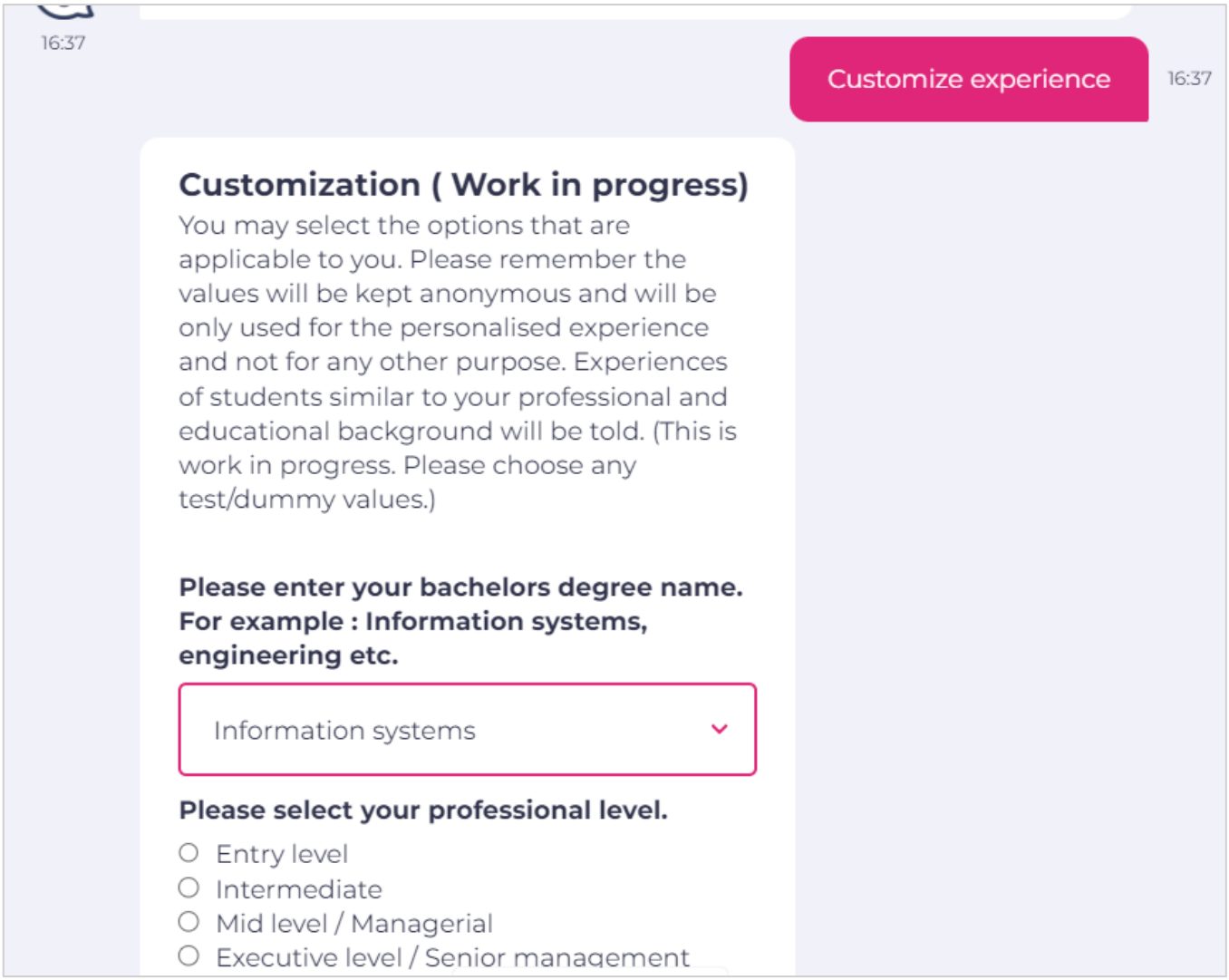



Figure 45 Flippy chatbot customization

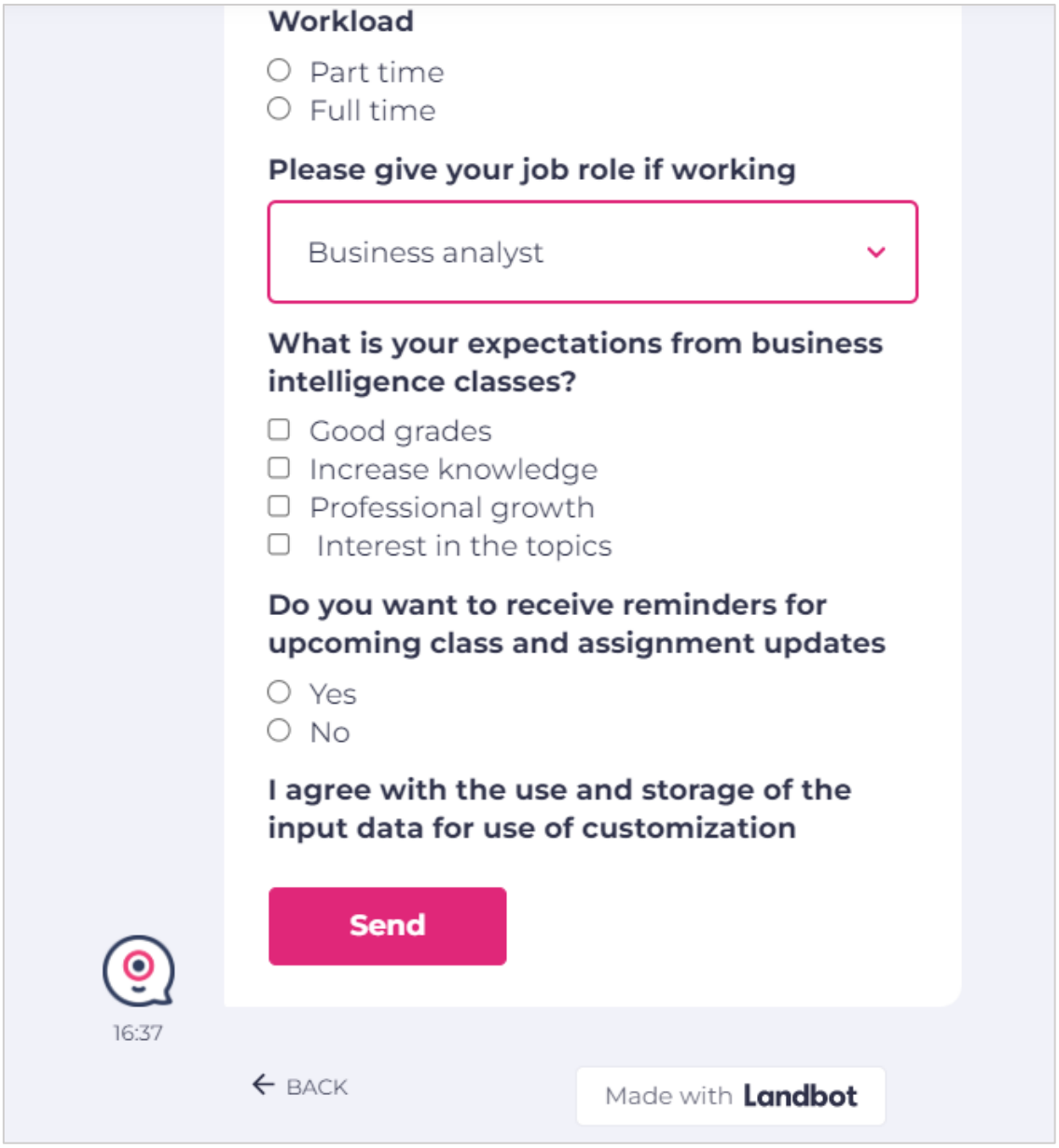



Figure 46 Flippy chatbot customization continued

l) If the student selects the quit application from the chatbot's main menu then the application gives a custom message for example: "*Hey Noel, sorry to see you go. Have fun with the learning assignment and the MDM topic. See you next week. Please don't forget to update your assignment book when you finish your assignment. Thanks*. This message would be custom based on the student interaction pattern. If the student leaves the chatbot early without going through all steps, then it will give some other message based on the situation for example: "Hey Noel you are leaving early. If you would like to see the other examples later, you are most welcome. See you soon. Bye". Refer to screen Figure 47.

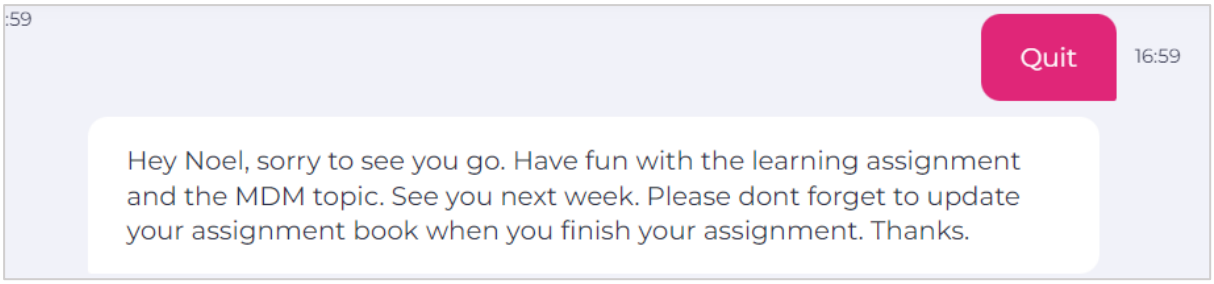



Figure 47 Flippy chatbot quit screen.

As we have seen the chatbot proof of concept was developed using the Landbot platform. The platform allows the designing of the chatbot. After the design, the chatbot can also be deployed on the Landbot platform for testing with a predefined number of test users. The chatbot can be seen on desktop and mobile applications. Following is the working link to the chatbot proof of concept: -
https://chats.landbot.io/v3/H-1167624-BL0S0RC64V8C5TAX/index.html

## 5.3 Generalization of the proposed chatbot

The chatbot described in the previous sections was designed for a flipped lesson "Multidimensional modeling" from the Business Intelligence (BI) module of the master's Program of Business Information Systems at FHNW, Switzerland. The chatbot can be generalized under the following contexts described in Figure 48. Following are the details of the different contexts: -

1. The Flippy chatbot proof of concept is showcased for the module "Business Intelligence". This module has lots of basic concepts and real-world usage examples. The concepts taught in this module have a positive impact on organizational people, processes, and technologies. It is a skill-intensive and professional module that provides the latest technical skills to students to solve problems within organizational processes. The chatbot imparts the importance of learning topics, and skills gained and gives real-world examples of the concepts taught in the learning topic. The proposed chatbot also shares learning and real-world learning and professional experiences of similar past student peer models with the students. The chatbot can be used in similar study programs and learning topics that are professionally oriented and impart a lot of skills and techniques for a professional career and have a positive impact on people, processes, technologies, and society at large. Please refer purple elements in Figure 48.
2. A chatbot like Flippy can also be used in studies where there is a lot of preparation content and a high workload of homework on the students specifically in a flipped class context (Prober and Khan, 2013; Moffett, 2015; Bouwmeester *et al.*, 2016). We know that in flipped classes due to the high workload load, there are low motivation levels (Sweller, 1988;

Simonson, 2017). The importance of topics can be also explained by the tutor before the beginning of the module or class. But tutors cannot be available every time, especially in a flipped class as tutors also have a high workload (Hung, 2017; Lin and Hwang, 2018; Li and Li, 2022). Students might forget what tutors talked about initially about the topic's significance at the start of the lesson or the semester. A chatbot will be available every time and can repeat the same topic multiple times without getting tired (Winquist and Carlson, 2014). The student can use the examples of important concepts via the chatbot to revise before the class or before an important exam rather than going through the whole materials again. Considering that students in the FC have a high workload and less time for preparation. Please refer green elements in Figure 48.

3. A chatbot like Flippy can also be used in study programs where there are diverse students both in educational and professional backgrounds. There will be students who might not have the necessary background in the topics taught in the course module like Business Intelligence. Instead of referring to the long preparation materials, such students will prefer to go through the Flippy chatbot and learn the experiences of peer models having similar as well as diverse backgrounds. Students who are working or want to earn a job would prefer to know the professional learning experiences of their similar peers via peer modeling delivered via the Flippy chatbot. Moreover, past peers might complete the course and leave the university and it will be difficult to contact them. Peer models incorporated into a chatbot will introduce past peers' learning experiences and strategies to the currently enrolled student. Please refer yellow elements in Figure 48.

In the next evaluation chapter, we look at how the proof of concept (Flippy chatbot) was tested and evaluated by the students and interpret their feedback and results. After the student evaluation feedback, the guidelines for designing similar chatbots are described.

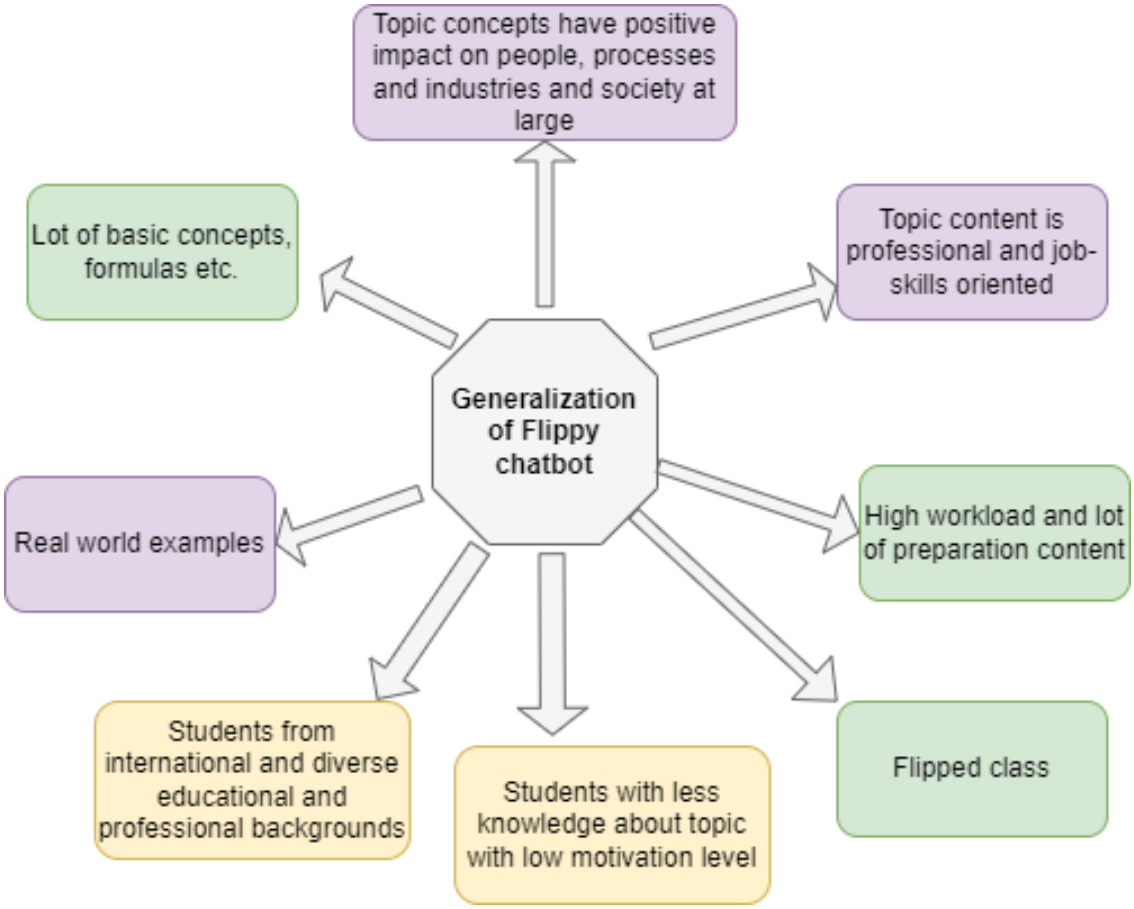



Figure 48 Generalization of Flippy Chatbot

## 5.4 Technical feasibility of the proposed chatbot

The proposed chatbot in sections 5.1, and 5.2 is a visual-centric conversation-style chatbot. It proposes predefined button inputs or quick replies to the FC students. Based on the predefined input the chatbot looks for the meaning of the input and based on its value takes a prebuilt action. Such a chatbot is also called (Alburger, 2018) a rule bot or decision tree bot. As discussed by (Winquist and Carlson, 2014) it is also called a flow chatbot where the paths are previously defined by the developer in a tree-based structure. The user's input is matched with the existing values in the database and if a match is found then the predefined answer is given to the user from the database otherwise an error is generated (Winquist and Carlson, 2014). Such types of rule-based chatbots are fast in processing user requests and giving back user responses and are highly accurate and reliable (Alburger, 2018).

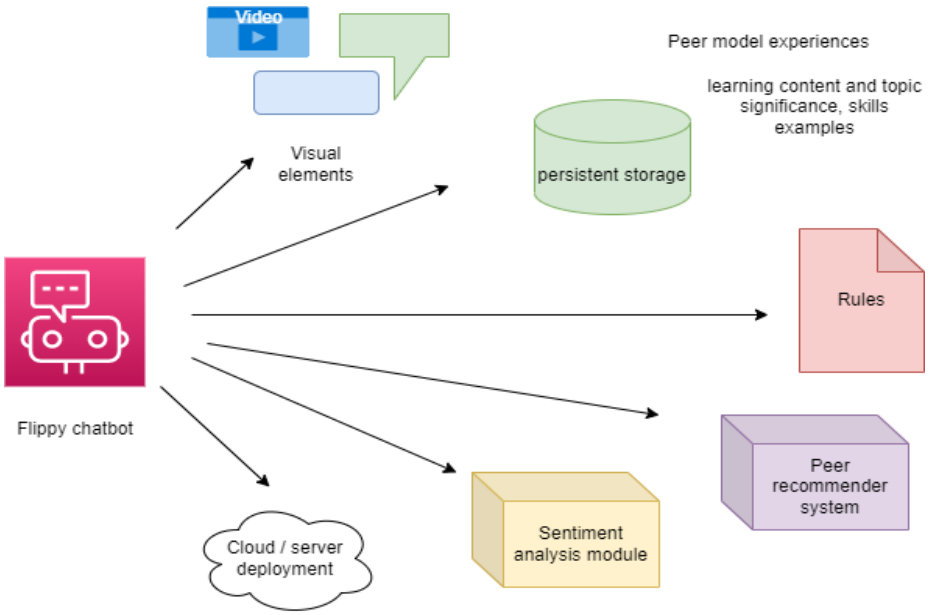



Figure 49 High-Level Components of Flippy

Figure 49 shows the different technologies that the Flippy chatbot will need to incorporate to be fully functional with the features discussed in the previous sections. The chatbot will need a visual chat interface and elements like buttons for user interaction. To store the content of the message for learning topics, significance, skills, examples, user customization settings, and peer model experiences it needs a database. It needs a rule base that defines the conditions to understand the user inputs and to take predefined actions and user responses based on the inputs. It needs a sentiment analysis module to understand students feeling about the upcoming topic in FC. A peer recommender system to recommend similar peers to students based on the similarity in their educational and professional background is needed. It also needs to be deployed publicly preferably on the cloud so that students could access it from their devices.

For designing and deploying the Flippy Chatbot for the initial student feedback and evaluation I have used the Landbot[8] environment. Landbot environment allows for design and automation and deploys chatbots in their environment. Landbot is relatively easier to build with standard features like user interface, different gateways, and conditions and provides free deployment of the chatbot up to a certain number of users and is a good option for initial evaluation purposes with no upfront development cost (Landbot, 2022). Landbot also provides a user logs functionality to track how users interacted with the chatbot and is a good choice for analysing student behaviours while evaluating the chatbot (Landbot, 2022). The features and the data/examples in the MDM proof of concept chatbot provide the experience

[8] https://landbot.io/

of PM and EILT factors to see the initial reaction of the students, and an impact on their intrinsic motivation and get their critical feedback for further iterations and improvement. If the students feel comfortable with the idea of the Flippy chatbot with concepts of PM and EILT then the advanced features can be developed which also include student suggestions and improvements. Concerning the proof-of-concept chatbot developed in Landbot following advanced features are simulated: -

1. Only important real-world examples and the important concepts of the Multidimensional modeling topic are showcased in the chatbot. The reason for this was to not overload the students initially with a lot of examples and just give them the most important highlights of the MDM learning topic. Hence the show more examples feature is not yet fully implemented.
2. Two peer modeling examples are showcased in the Flippy chatbot one with a video and text narration and another with only text narration to see the initial reaction/suggestions of the students concerning the peer modeling concept and their preference for the peer model delivery method (video, text narration). *The Landbot tool doesn't support a custom similar peer recommender mechanism feature now*. Hence the recommended/showcased similar peer models in the Landbot chatbot is not similar but are only a simulation to demonstrate the idea to the students and get their feedback. The data in the customization form is not used for user personalization or peer modeling.
3. The chatbot asks the students for their opinion of how they felt about the learning topic. Based on the positive/negative input of the students a custom message would ideally be given to the students. The custom message for the sentiment check is only a simulation in the chatbot and no actual sentiment check takes place in the background.

   The Landbot tool is suitable for making the initial proof of concept to get the first feedback and reaction of students. But Landbot doesn't provide any custom integrations with a similar peer recommendation feature for peer modeling. Hence a separate custom similar peer recommendation proof of concept is developed in Java language to showcase the concept of finding similar students based on their similar education and professional background. It is described in section 5.5. To integrate and test the custom java similar peer recommender system a java based chatbot is developed in Microsoft Bot Framework[9]

[9] https://azure.microsoft.com/en-us/services/bot-services/?&ef_id=CjwKCAjw7IeUBhBbEiwADhiEMcUSA4bkbxgrd6GhIOGcmSGNYryugEtpO7mgXDWpJFC73zk8EWLDgxoCo6MQAvD_BwE:G:s&OCID=AID2200264_SEM_CjwKCAjw7IeUBhBbEiwADhiEMcUSA4bkbxgrd6GhIOGcmSGNYryugEtpO7mgXDWpJFC73zk8EWLDgxoCo6MQAvD_BwE:G:s&gclid=CjwKCAjw7IeUBhBbEiwADhiEMcUSA4bkbxgrd6GhIOGcmSGNYryugEtpO7mgXDWpJFC73zk8EWLDgxoCo6MQAvD_BwE#overview

SDK. Microsoft Bot Framework is used by chatbot developers to design and build a custom conversational chatbot from scratch. It has the following features: -

1. It allows developers to build both rules-based and AI-based chatbots from scratch in multiple languages like Java, and C# (Microsoft, 2022a). We can also integrate the peer modeling similarity subsystem made in section 5.5 in this flippy chatbot as it also supports Java. It provides tools to design, develop, test, and deploy the custom chatbot (Microsoft, 2022a).
2. The screens of the chatbot with visual elements like buttons and their rules can be developed in Java with the Microsoft framework (Microsoft, 2022c). Images and videos can also be added to the chatbot responses (Microsoft, 2022d).
3. The SDK framework also allows for persisting and retrieving data from the database (Microsoft, 2022b, 2022e).
4. It also provides advanced modules or web service API for sentiment analysis to detect positive or negative sentiment in the text phrase (Microsoft, 2021).

There are similar frameworks like DialogFlow[10] that provide similar features for developing a chatbot and are not in the scope of the thesis.

I made a similar proof of concept for the Flippy chatbot using the Microsoft Bot Framework. Figure 50 shows the screenshot of the Flippy chatbot developed in the Microsoft Bot Framework. In the figure, the chatbot is running in the Bot framework emulator where one can see the request and response in the user bot communication. Figure 51 shows the code of the Flippy Chatbot developed in the Microsoft Bot Framework. The following are the features implemented using this framework: -

1. This proof of concept has the same features of PM and EILT as designed in the chatbot using the Landbot tool. It showcases the example of the MDM topic.
2. The data for the learning topic (skills, importance, examples) are read by the Java program from a template file. This code can be customized for any other learning topic with minor changes in the template file.
3. A similar peer recommender system developed in Java is integrated into the Microsoft Bot Java chatbot as a proof of concept. The user can set the degree, professional role, workload, and professional level in the customization section. Once the student background data is saved, similar peers are found from the database for the given input student based on the case-based reasoning similarity techniques. Now only 2 most similar peer experiences are narrated. The links to the code repository are given in Appendix section 8.8 along with the other resources.

[10] Dialogflow CX documentation | Google Cloud

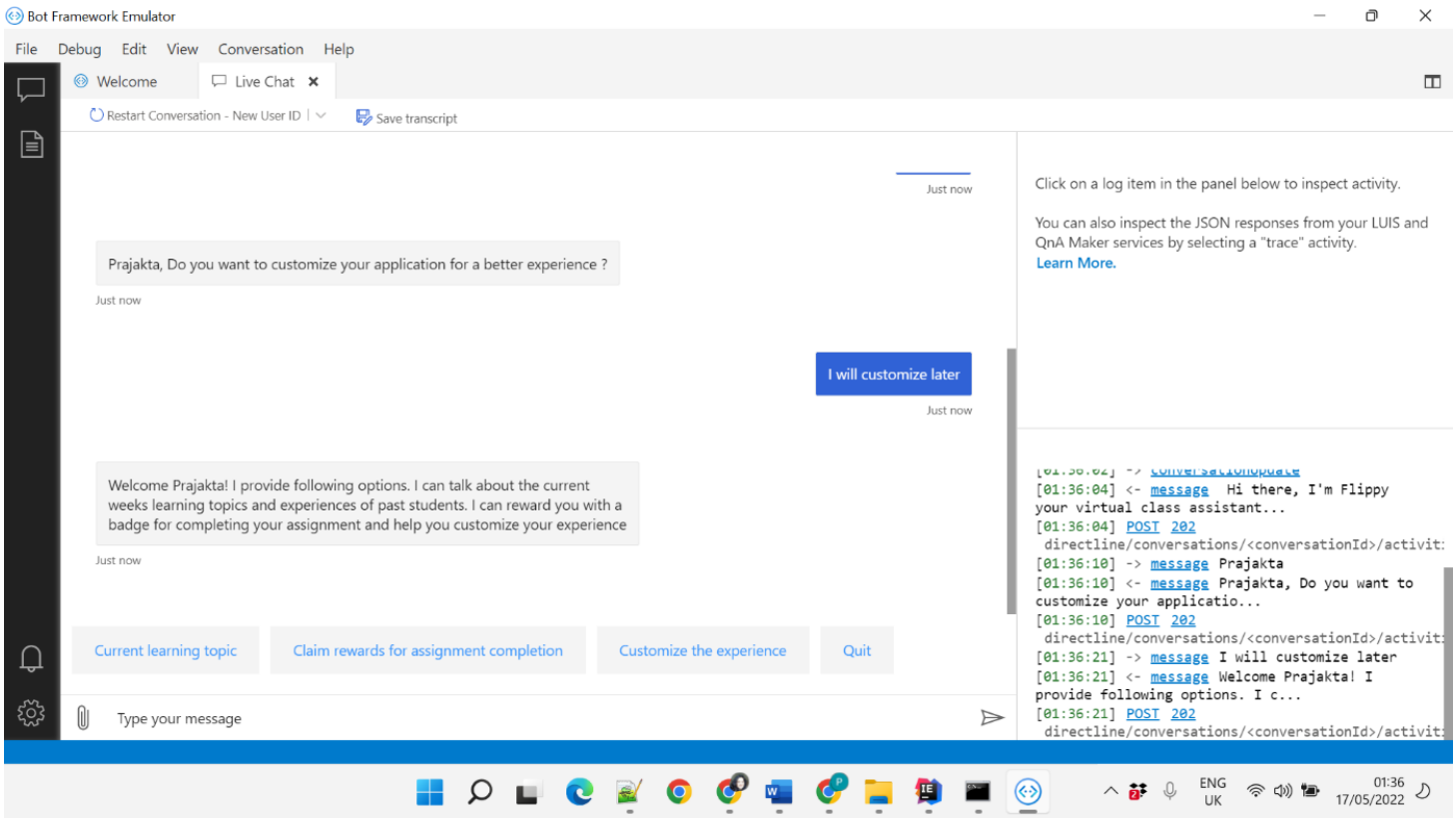



Figure 50 Flippy running in the Microsoft emulator.

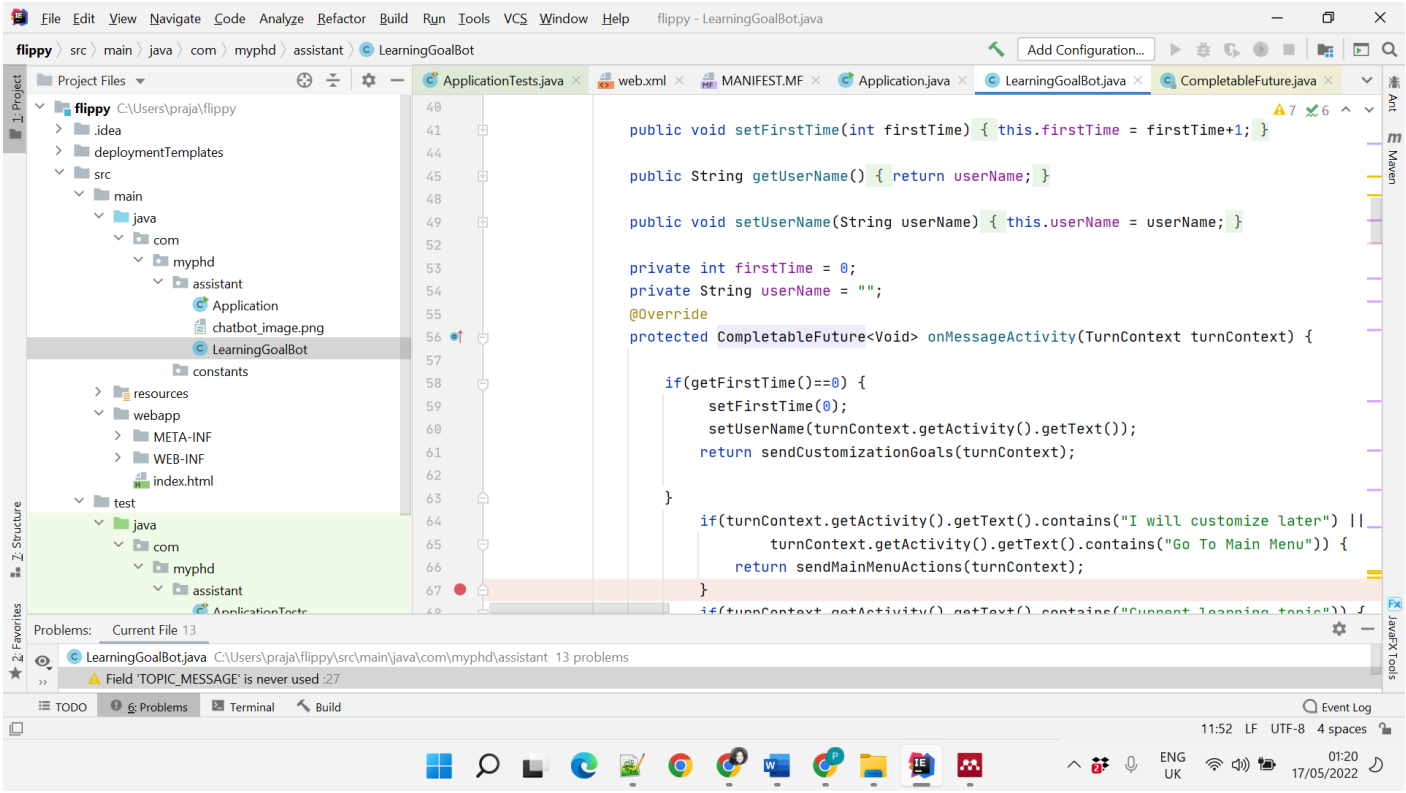



Figure 51 Code Sample of Flippy in the Java editor

## 5.5 Similar peer model recommender system

In the previous sections (5.1, 5.2) in this chapter the thesis showcases the peer modeling concepts in the Flippy chatbot. The chatbot shows the peer model experiences to students via video and text narration concerning the MDM topic. It is known that usually similar peers are recommended for peer modeling. Peer student models with similar backgrounds are effective in building competency in students (Thelen *et al.*, 1979; Bandura, 1986; Schunk, 1987; Muir, 2018). Flippy design gives the customization section for this recommendation of similar peers for motivating students. Thus, the design of Flippy gives autonomy to students to set their preferences for similar peer modeling. The similarity is based on the educational and professional backgrounds of the students and their peer models (Murphey, 1996, 1998, 1999, 2003; Murphey and Arao, 2001; Muir, 2018). The students could set their educational and professional background data. Based on student settings, the chatbot finds similar peer models (with similar educational and professional profiles), and their experiences are delivered to the student. Since the Landbot tool does not have any inbuilt tool for such a similar peer recommendation a second proof of concept is built. This proof of concept is built to showcase the functionality of similar peer recommendations to the students who use the chatbot. Also, how the concept of similar peer models can be implemented in a chatbot like Flippy for peer modeling is shown in this chatbot. This second proof of concept is like the recommender systems in technology-enhanced learning.

This chapter initially describes the concept of recommender systems in technology-enhanced learning. Then it later gives an overview of the proof of concept of the Java-based similar peer recommendation system based on the case-based reasoning technique that recommends similar students for peer modeling considering students' professional and educational backgrounds.

### 5.5.1 Recommender systems in TEL

In technology-enhanced learning (TEL), many recommender systems (RecSys) are used that recommend suitable learning assignments/activities to students based on their current knowledge level. This knowledge of students is calculated by their past self-assessment methods and is used to recommend/deliver a personalized learning experience to students (Drachsler *et al.*, 2015). This trend has increased with the rise of massive online learning courses (MOOC), where a high amount of student data is being generated and this data is analyzed/used in recommender systems to provide a personalized experience for students (Masters, 2011; Drachsler *et al.*, 2015).

Recommender systems can be classified as having different technologies and algorithms. Recommender systems use algorithms to try to find connections between items and users and give efficient results (Lika, Kolomvatsos and Hadjiefthymiades, 2014). The most used

techniques used in recommender systems are content and collaborative filtering (Drachsler *et al.*, 2015; Tadlaoui *et al.*, 2018). Collaborative filtering recommends resources/items based on the similarity between the settings/preferences of different users (Goldberg *et al.*, 1992; Tadlaoui *et al.*, 2018). While content-based filtering recommends items to the user by comparing the item's description content to the user's preferences/settings (Pazzani and Billsus, 2007; Tadlaoui *et al.*, 2018). Technology-enhanced learning recommender systems have been used for recommending appropriate learning resources to students based on the evaluations and ratings given to learning resources by past students (Recker and Walker, 2003; Lemire *et al.*, 2005; Drachsler *et al.*, 2015). In informal learning settings, recommender systems are used to recommend previously tagged learning resources from multiple social websites like Flickr[11], Slideshare[12], etc in mashup environments (Drachsler *et al.*, 2009). Such a mashup environment combines different learning sources from social media in a single learning environment. Such systems make use of the already tagged and rated resources on the respective social media sites for a student recommendation (Drachsler *et al.*, 2009). But both the content and collaborative filter mechanisms need a lot of user information datasets, for example, historical user-system interaction data, users' interests/preferences, and product/item ratings to train and test otherwise they don't produce efficient recommendations (Lorenzi and Ricci, 2005). This can become an issue when a new system is introduced and there is not much data available for applying these techniques. This is also known as a cold start problem (Lika, Kolomvatsos and Hadjiefthymiades, 2014).

To fix the cold start problem, knowledge-based recommender systems are used (Lorenzi and Ricci, 2005). Such systems use knowledge about the end user and the application domain while recommending the items/products to the end user (Lorenzi and Ricci, 2005). It doesn't need a lot of training data and can work with small data sets as well (Lorenzi and Ricci, 2005). Knowledge about the user profile is modelled in a detailed user model. This knowledge doesn't depend on users' ratings etc (Lorenzi and Ricci, 2005). Case-based reasoning (CBR) is generally used in a knowledge-based recommender system that models past experiences as cases and tries to solve a new problem based on the modelled cases (Kolodner, 1993; Lorenzi and Ricci, 2005). For solving a problem, the case-based reasoning system finds a similar case and uses the solution of the case to solve the problem (Kolodner, 1993; Lorenzi and Ricci, 2005).

In a case-based system, the old experiences are stored as cases that are pairs of problem solutions (Bergmann, 2002). For a given new problem a similar case or problem already

[11] https://www.flickr.com/

[12] https://www.slideshare.net/

existing is found from the case base, the solution in the case is reused and adapted to suit the new problem and further, this new problem with the adapted solution is stored in the case again for further use (Bergmann, 2002). The similarity of the cases is found by comparing the similarity between old and new problems. It is assumed that the solution to the old problem can be reused for the new one (Bergmann, 2002). In the peer modeling context, one can relate a case to a student object which contains the background information (profile of the student) and other learning experience information. The similarity of cases is an important concept in CBR because all the core concepts related to case management like case creation, and case search are based on similarity measures and metrics (Finnie and Sun, 2002)

In the chatbot Flippy, the CBR technique is a better approach to recommend similar peer models for the peer modeling factor. At the start of the new system, there is no student user interaction data with the chatbot as well as learning materials/objects. The concepts from case-based reasoning (CBR) are used in a similar peer model finding mechanism as it provides techniques for representing, storing, and retrieving experiences (Bergmann, 2002). CBR provides rich techniques for modeling storing, retrieving, reusing, and evaluating experiences and their knowledge (Bergmann, 2002). We can say that in the thesis, peer modeling is used to model the learning experiences of students (peer model) for building intrinsic motivation among students. One of the goals is to model these experiences of past students so that they can be used in the chatbot tool in the FC preparation. The student's educational and professional information along with their learning experiences is mapped to the case concept described in the thesis section 2.3.3. This information is obtained from student surveys and interviews with students' prior consent. The thesis uses the concept of using similar peer model experiences to intrinsically motivate students. The similarity is based on the educational and professional background information of the students. This background information is in the non-numeric format for example bachelor's degree, workload, professional roles, and professional level. The CBR mechanism provides the similarity techniques and algorithms/formulas for finding similar cases/objects that have non-numeric attributes and features (Bergmann, 2002). A similarity function or similarity measure is used to find similar cases (Donner and Roth-Berghofer, 1999; Bergmann, 2002).

The details of the proof of concept of the similar peer model recommender system are described in detail in the next section.

### 5.5.2 Proof of concept for similar peer modeling recommender system

To find similar peers in the Flippy chatbot certain student background attributes are defined. We have seen that students feel confident and motivated when they observe similarly abled peers performing and succeeding in solving a task or activity (Bandura, 1997; Zimmerman,

2000; McQuiggan, Mott and Lester, 2008; Ohtani *et al.*, 2013). An anonymous student survey in section 8.3 was conducted in the FHNW, "Business Intelligence class" to understand the background and profile of the students. Prior permission to use the data in the thesis work was taken from the students. We have seen in the literature review that attributes related to the following information are generally used for peer modeling similarity namely age, gender, nationality, culture, background (educational, social, professional), demographic, competency information (skills, knowledge level) (Murphey, 1996, 1998, 1999, 2003; Murphey and Murakami, 1998; Murphey and Arao, 2001; Muir, 2018). The questions in the survey were mostly related to these above-mentioned attributes. Based on the relevance of those attributes to the FHNW master's degree program and Business Intelligence module the attributes shown in Table 7 were selected for the Flippy chatbot. The following similarity attributes are selected for the similar peer mechanism for the MSc BIS module: -

- Students from different educational backgrounds like computer science, engineering, and business administration enroll in the master's program. Students' educational backgrounds will be compared based on their educational bachelor's degrees. Students having similar degrees have similar knowledge and learning experiences and hence can relate to each other (Murphey, 1996, 1998, 1999, 2003; Murphey and Murakami, 1998; Murphey and Arao, 2001; Muir, 2018).
- In the Business Intelligence class, many students have different professional levels based on their job roles and years and types of experience and knowledge. The professional levels[13] for such students can be as follows: -
    - Fresher or entry-level where people immediately join work after completing their education.
    - At the intermediate level, people gain a few years of experience in their respective fields and work independently with less supervision from managers.
    - Mid-level-Managerial level people usually hold managerial positions and manage the goals of one or more departments.
    - Executive / Management level hold considerable experience in one or more fields and with that, they obtain executive positions and manage the goals of the whole organization.
- In the survey results, it was found that there is a good mix of students in the Business Intelligence class working in different roles in different domains. In the student surveys, a few common roles are observed for example business analyst, project manager, and developer. For example, IT business analyst and developer roles might be similar in the

[13] https://www.indeed.com/career-advice/finding-a-job/work-experience

sense that the former role also involves some development possibilities. The professional roles thus serve as one of the similarity measures in the Business Intelligence module. Students would see the success story of past students with similar roles and can easily relate to the peer experiences and get motivated. One such example of peer experiences will be how the learning topic helped students in their professional work.

- MSc BIS is an international degree program that is taken by professional working and non-working students. It is evident from the survey data that some students do the course part-time and have a professional responsibility while some students pursue the course full-time and don't work. Hence, we use the percentage of work as an attribute which has 3 values non-working, full-time working, and part-time working.

Table 7 List of peer model attributes for the Flippy chatbot

| No | Attribute | Category |
|---|---|---|
| 1 | Bachelor's degree | Educational background |
| 2 | Professional level | Professional background |
| 3 | Job role | Professional background |
| 4 | Percentage of work | Professional background |

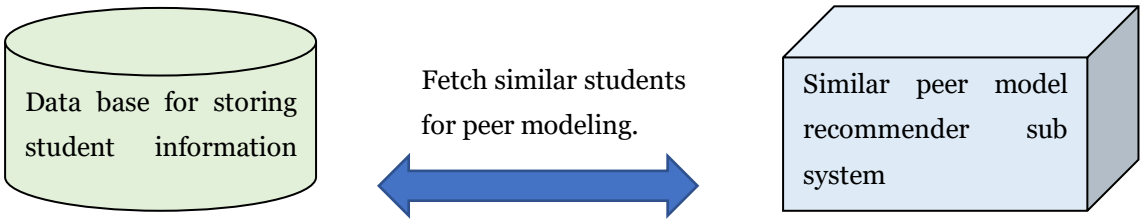



Figure 52 Technical architecture of the similar peer recommender system

A similar peer recommender system for peer modeling is implemented in the Java [14] program as a proof of concept. The similarity attributes along with the similarity measures are calculated and stored in the system. Please refer to Figure 52 above for the high-level technical architecture of the similar peer model recommender sub-system. At first, the local similarity value for each student's background attribute is calculated. Then the global similarity at the

[14] https://www.java.com/en/

student level is calculated. To compare two students on their attribute similarity their global similarity measure is compared. It is usually a value between 0 to 1 (Bergmann, 2002). By default, this database will contain the historical data of past peer students and their experiences concerning the concepts of peer modeling. This data will contain students' educational and professional backgrounds for example bachelor's degree, workload, professional level, and job role. The database will also contain the pre-calculated similarity measures between the pre-existing values of each attribute. These similarity measures will be used as a reference for calculating the local and global similarities. For each student's further peer model experiences in the form of text narrations or messages, links to videos would also be stored. The concepts for calculating similarity measures are discussed in the context of case-based reasoning in section 2.3.3. Now the proof of concept is developed with a sample data set of students from the MSc BIS student surveys and interviews. Following students, profile attributes and their values are used in the proof of concept of the similar peer model recommender system.

1. Professional level is a symbolic attribute. A symbolic attribute can have some numeric order defined on it (Bergmann, 2002). A professional-level[15] can be entry-level, Intermediate, Mid-level/Managerial, or Senior Executive these are the different experience levels and can be given ordered numbers as 1,2,3,4 as the work experience and responsibility increase in the given order. The student can enter one of these values. For comparison between such attributes, we need to calculate the similarity between each of the levels with each other (Bergmann, 2002). A matrix is used to calculate and depict such similarity measures (Bergmann, 2002). The local similarity value for two students based on the attribute professional level one with entry-level and the other with managerial level is 0.5. Please refer to Figure 53 for the matrix calculation.

| | Values | Entry level | Entry level | Mid-level/Managerial | Senior Executive |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| Entry level | 1 | 1 | 0.75 | 0.5 | 0.25 |
| Intermediate | 2 | 0.75 | 1 | 0.75 | 0.5 |
| Mid-level/Managerial | 3 | 0.5 | 0.75 | 1 | 0.75 |
| Senior Executive | 4 | 0.25 | 0.5 | 0.75 | 1 |

Figure 53 The similarity measure matrix for the professional level

2. I calculate similarity measures for the student workload of the students in the master's program. The values for the workload are ordered numbers from 0 to 2 where 0 refers to Not applicable, 1 means part-time and 2 means Full-time workload. As the workload is increasing from left to right numeric values are given to the workload at an increasing level.

[15] https://www.indeed.com/career-advice/finding-a-job/work-experience

Not applicable means the student is not working, part-time means the student is working part-time, and full-time means the student is working full-time. A similar matrix is calculated for the workload attribute. Please refer to Figure 54 below for the similarity matrix.

| | | Not applicable | Part time | Full time |
|---|---|---|---|---|
| | Values | 0 | 1 | 2 |
| Not applicable | 0 | 1 | 0.5 | 0 |
| Part time | 1 | 0.5 | 1 | 0.5 |
| Full time | 2 | 0 | 0.5 | 1 |

Figure 54 The similarity measure matrix for the knowledge level

3. For similarity measures for symbolic attributes where there is an order, it is suggested to assign ordered numbers and then compute a matrix to calculate similarities between each of these values (Bergmann, 2002). For the professional level order is observed from entry-level until the executive managerial position is increasing order concerning years of experience. A similar order is also observed for the workload.
4. A professional degree is also a symbolic attribute. A symbolic attribute is stored in a tree-like structure or a taxonomy as it can contain multiple values (Bergmann, 2002). Taxonomy is an n-nary tree where the nodes contain the attribute values (Bergmann, 2002). Apart from the values taxonomy also represents the additional relationship between the nodes depending on their position in the taxonomy tree (Bergmann, 2002). Leaf nodes contain concrete objects, and the similarity of the objects is the similarity value of the most common predecessor of the compared nodes (Bergmann, 2002). Taxonomy is prepared to group the attribute values hierarchically when attribute values in this case have hierarchical values or fall into different categories (Bergmann, 2002; Cunningham, 2009). In the bachelor's degree taxonomy, the root nodes contain the names of the bachelor's degree of students, and they are grouped into different sub-trees based on their categories. The courses in the categories are similar. The similarity measures are annotated manually based on the similarity of the topics covered in the respective degrees of the students. For degree courses, the similarity between the bachelor's degree courses that students completed before they enrolled in the master's in business information systems class is analysed based on several factors. These factors are based on the categories like engineering, management, computing, business, etc. Based on the degrees and their similarities a taxonomy is built as shown in Figure 55.

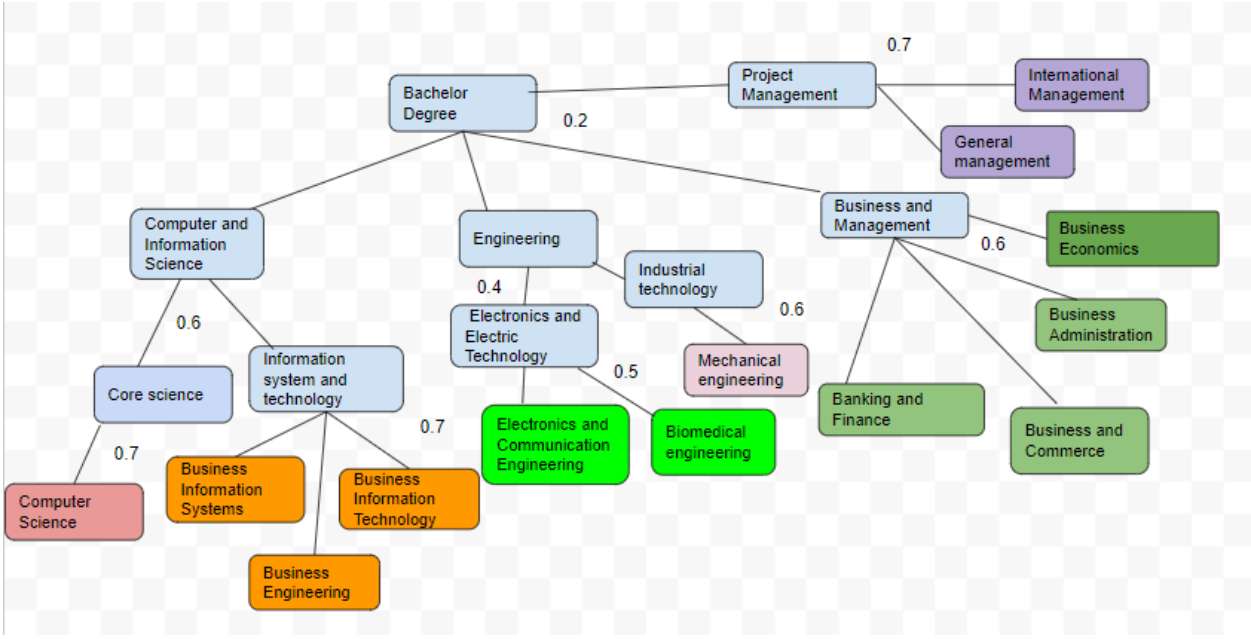



Figure 55 The similarity taxonomy for the bachelor's degree of students

5. Professional roles are grouped based on the task and activities that they perform. A taxonomy is created, and similarity measures are manually assigned to them. Similar roles are grouped in a particular subtree of the taxonomy. For example, managerial roles will be grouped into junior project manager, and IT project manager while software development-related roles like software developer and requirements engineer.

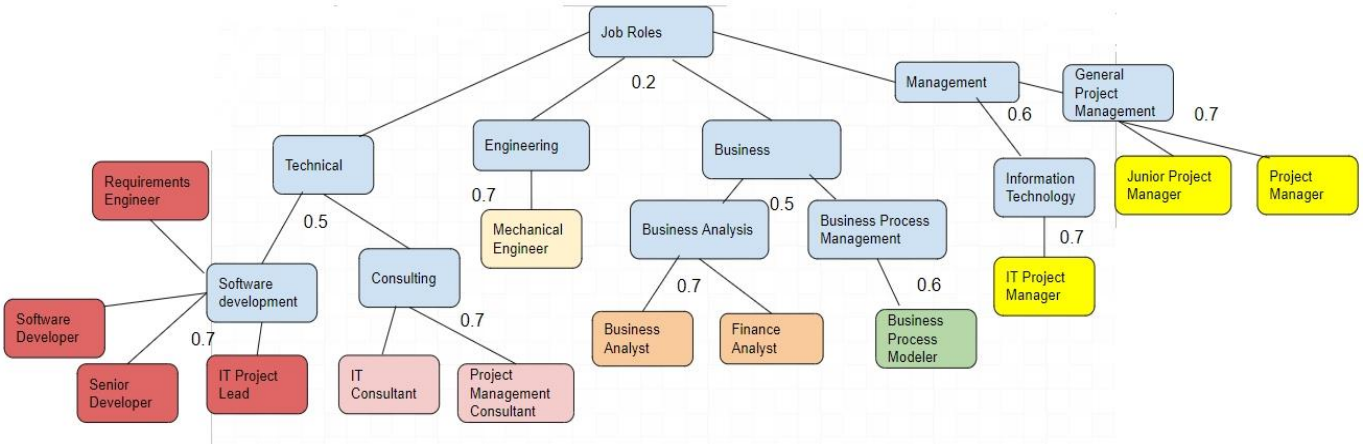



Figure 56 Taxonomy for professional roles

grouped. Please refer to the taxonomy of roles in Figure 57. The roles are present at the root nodes.

The similarity is measured using a similarity measure function $sim : D \times D \rightarrow [0, 1]$ and is expressed as a numerical value (Bergmann, 2002). If the output has a value on the higher side, then the similarity between the two values is high and if the output is on the lower side, then the similarity is low (Bergmann, 2002). Usually, the similarity is expressed as a value between

0 to 1. Zero means least similar and 1 means identical (Bergmann, 2002). In terms of similarity between objects in case base reasoning, the local similarity of attributes at the attribute level is calculated which is called local similarity (Bergmann, 2002). For the global similarity, a weighted average of the local similarity values is considered while the calculation represents the whole case object as such (Bergmann, 2002). The formula for local similarity for numeric values (Bergmann, 2002) is used below.

$$f(d) = \begin{cases} 1 & : \quad d < min \\ \frac{max - d}{max - min} & : \quad min \leq d \leq max \\ 0 & : \quad d > max \end{cases}$$

Figure 57 Local similarity formula (Bergmann, 2002)

In Figure 57 the linear function states that the similarity of two values decreases linearly with an increase in the difference between the two values (Bergmann, 2002). This function is used to calculate the local similarity of numeric attributes. The global similarity is calculated by using an aggregation function on the local similarities of the attributes. Usually, a weighted aggregate function is used (Bergmann, 2002). Each attribute is given a weight based on its importance to calculate global similarity (Bergmann, 2002). Please refer to Figure 58.

$$\Phi(s_1, \ldots, s_n) = \sum_{i=1}^{n} \omega_i \cdot s_i \qquad \text{(Weighted Average Aggregation)}$$

Figure 58 Aggregate function for Global similarity (Bergmann, 2002)

The data for students and the attributes and similarity values are stored in a database that is used by the recommender system to find similar students to a particular input student based on the similarity values. This calculation of local and global similarity is done in the Java code. The Java program takes the input of student data with name, degree, role, workload, and professional level. The Java program calculates the local similarities for every attribute of the input student with the attributes of all past students in the cases for that module. The global similarity is then calculated for the input student with the past students in the cases The recommended similar peer students are sorted in descending manner based on their global similarity value with the first student being most like the given input student. The value of similarity is between 0 to 1.

In the database, (Arango DB[16]) used for the student data, the taxonomies and the matrices mentioned above are modelled as graphs/tree-like structures for easy traversal and similarity

[16] https://www.arangodb.com/

measures retrieval (Irniger and Bunke, 2004). Arango DB is an open-source database that supports the storage of knowledge in the form of graphs which is a set of vertices and edges. Edges are the relations between the data objects or vertices and contain similarity measures. Vertices represent the degrees and the degree categories. Arango DB also supports the storage of the collection of data as documents (ArangoDB, 2021). Please refer to Figure 59, Figure 60, Figure 61, and Figure 62 for the modelled graphs.

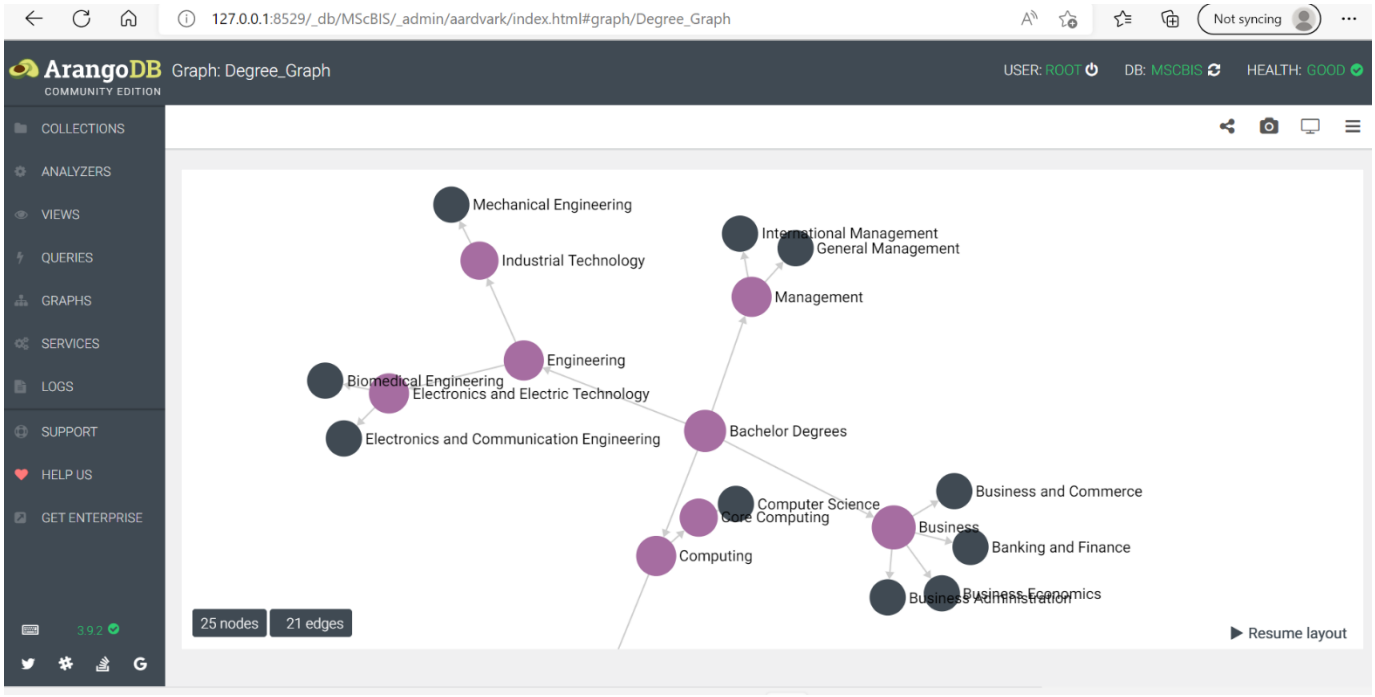



Figure 59 Bachelor's degree taxonomy modelled as a graph in the database[17]

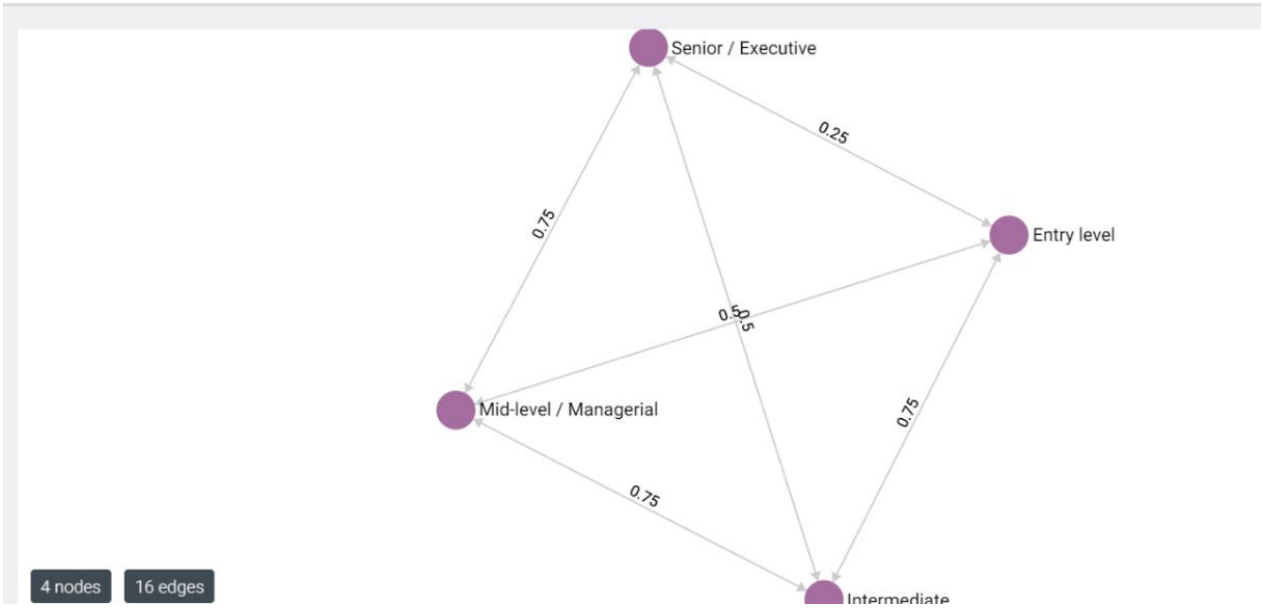



Figure 60 Professional level matrix modelled as a graph in database.

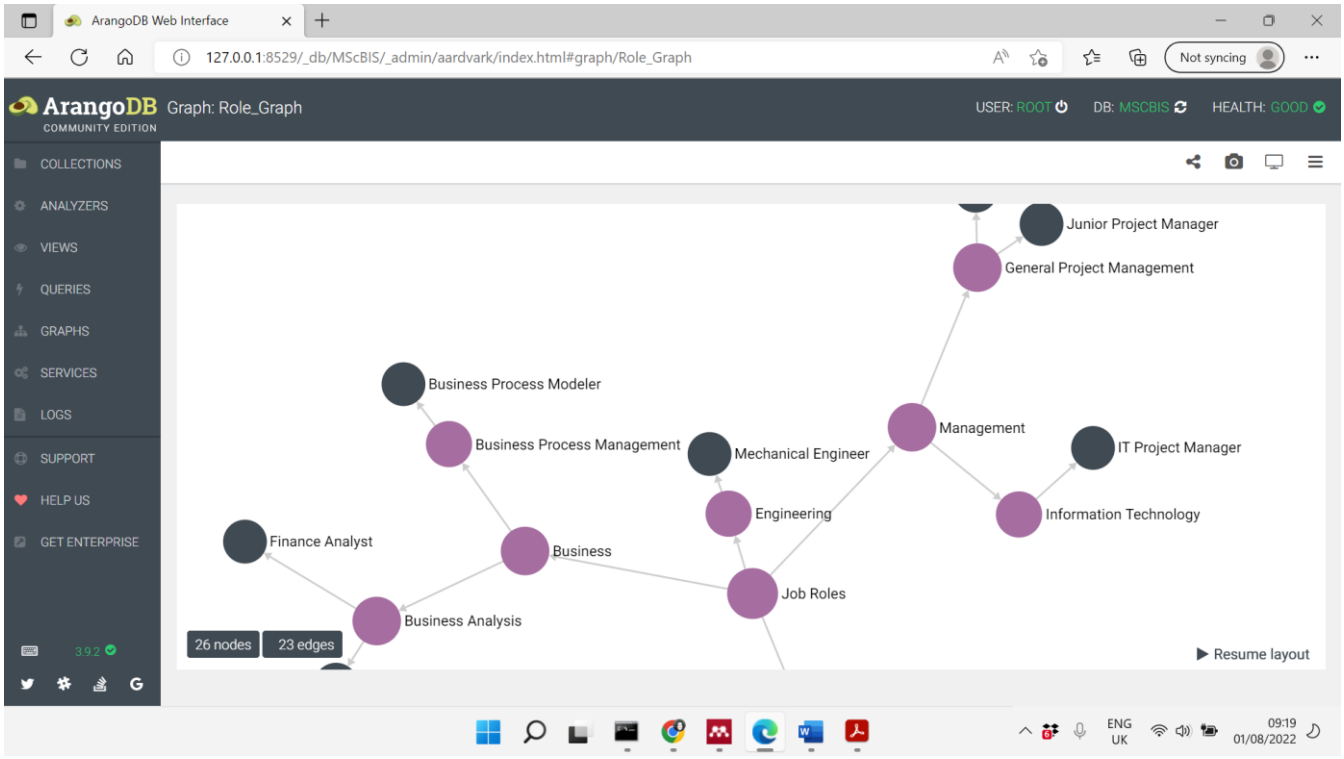



Figure 61 Professional roles taxonomy modelled as a graph in the database.

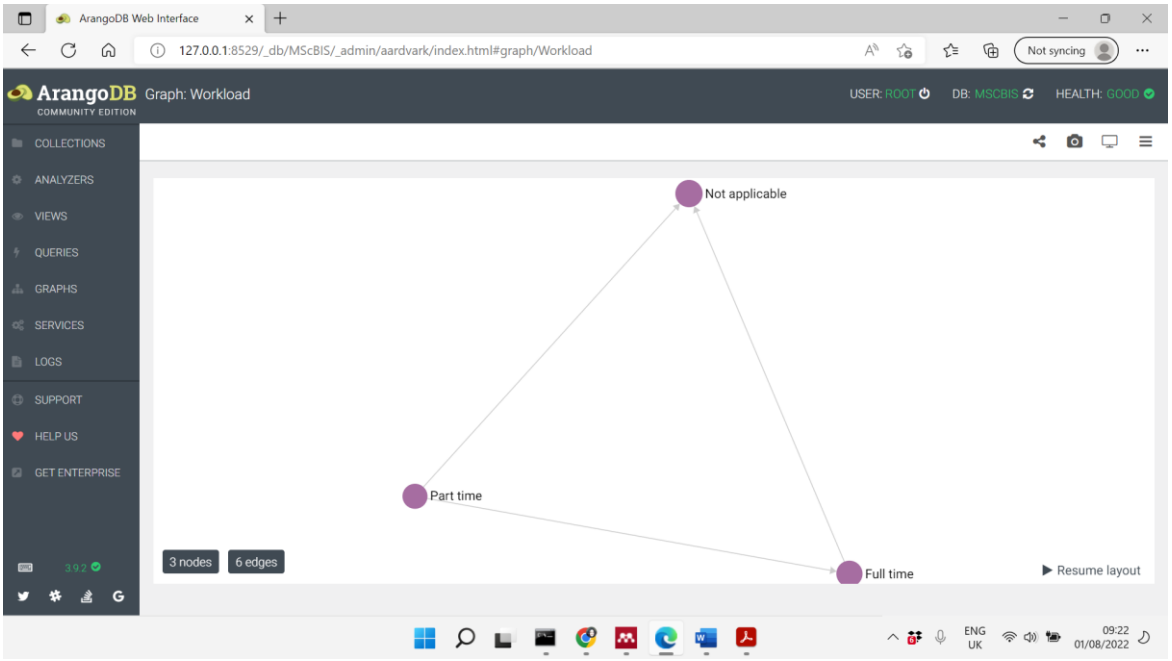



Figure 62 Workload matrix modeled as a graph.

Figure 63 shows the Java program written for recommending similar peers to a student with a particular profile. It recommends all similar students to the input student in descending manner based on the global similarity measure. The higher the global similarity the more similar the student is to the input student and vice versa. The topmost student is the most similar student to the input student.

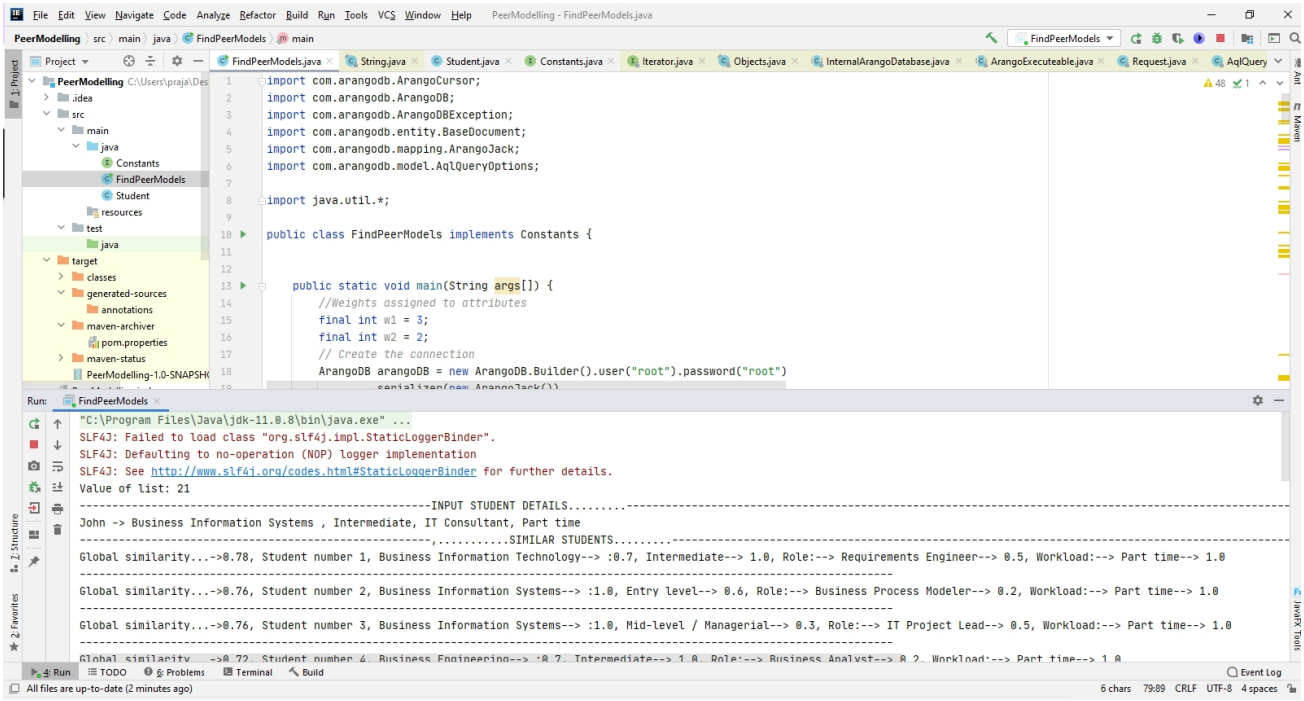



Figure 63 Java Program to demonstrate recommendation of similar near-peer models.

The CBR concepts are used in the proof of concept to show how similar peers are found for peer modeling concepts for the chatbot tool. The proof of concept has a few limitations: -

1. The CBR techniques for similarity are used to show the concept implementation of similar students based on background data and do not analyse the efficiency of such techniques. There may be other efficient techniques that need to be investigated for implementing a similar peer modeling recommender system and is not part of the thesis study.
2. Custom taxonomies are made for the simplicity of their use in the Java program. Also, the MSc BIS master's program is taken by international students from diverse backgrounds and their bachelor's programs are named differently in different languages. Moreover, there are various online taxonomies with slightly different structures for the same degree. Based on the interpretation of these degree programs and professional roles custom taxonomy samples are made. Data is limited to the sample data of students from the student surveys from the MSC BIS program. The taxonomies and the matrices for the professional degree, roles, and professional level are created by analysing different online resources like degree definitions from university websites, articles, online taxonomies, etc. The links are provided in Appendix Section 8.6.

# Chapter 6: Evaluation of the Proof of Concept

We have seen the proposed chatbot Flippy with PM and EILT to build intrinsic motivation among the students in the flipped class developed using the Landbot tool in section 5.2. This artifact developed using Landbot (Link to FLippy ) is the final artifact that is presented to a group of students in the flipped class of "*Multidimensional modeling*" for evaluation purposes. In section 5.4 the simulation features of the Flippy chatbot are also mentioned. In this section, we analyse how the student's intrinsic motivation is impacted after using the proposed chatbot Flippy as mentioned in one of the research sub-questions in section 1.2. The student's suggestions and opinions about the features of the chatbot are also discussed. Both case studies and expert surveys are part of the suggested evaluation strategies in the outline of the design science research process by research practitioners (Offermann *et al.*, 2009). A case study is recommended for evaluation to see the applicability and relevance of the research artifact in the real-world context (Offermann *et al.*, 2009). While in the expert surveys' users are asked if they were interested in the solution and whether they felt it solved the problem (Offermann *et al.*, 2009). Both these approaches are used in the evaluation of the proof of concept.

## 6.1 Chatbot test in the flipped class

In the thesis, the chatbot designed for the flipped lesson "Multidimensional modeling" is the research artifact. In the evaluation phase, the artifact must be checked for its utility and efficiency and whether it is capable to solve the research problem (Hevner and Chatterjee, 2010; Carcary, 2011). In the spring semester of 2022, the chatbot link was shared with the students in the flipped lesson on the 12th of March, Saturday via email. The *multidimensional modeling* flipped class was to be conducted on the 19th of March. Students got one week in advance to prepare for the upcoming flipped class. The class for BI happens in 2 groups, one in the morning and one in the afternoon. The afternoon class was sent the link to the chatbot along with the information that the chatbot was used for research purposes to help students prepare for flipped class and that they might have to fill in their usernames. If they don't feel comfortable, they were told to use any other test names. Students were also notified that the chatbot tool keeps track of their interactions and that they would be studied for research work. Students were informed in advance that the chatbot is a work in progress and that some functionalities like peer similarity and user personalization are a simulation. In addition, the students needed to fill out the online consent form to permit us to use their interaction data for Ph.D. research work. The morning group of students served as a control group. It was sent out regular emails with links to assignments in the Moodle LMS without the link of the chatbot.

The number of students in the chatbot group was 36 while in the non-chatbot group were 35 students. The logs from the student chatbot interaction were analysed and the summary is

given in Table 9. Fourteen students (39%) of 36 students accessed the chatbot. During the chatbot interaction, students were asked *how they felt* about the learning topic when they learned about the importance of the topic and the skills gained. Students were asked to give their answers in one word. Please refer to Table 8 and the column named *Feeling*. Almost half of the total participating students replied as interested, curious, and felt good after hearing about the introduction, importance, skills gained, and examples of the *Multidimensional modeling* learning topic. This data along with other interaction data is given in Table 8. This figure gives more detailed information about the users who interacted with the chatbot and whether after the interaction they went to the Moodle LMS to do the preparation and the quiz. Table 8 contains the information on the sections that the user visited in the chatbot along with the date and time of chatbot access and the date of access to learning objects (quiz) and the date and time of the completion of learning object (quiz) on the Moodle LMS.

| No | Student name | Attempts | Chatbot paths traversed | Feeling | Chatbot interaction | LMS start time | LMS End time |
|---|---|---|---|---|---|---|---|
| 1 | A | 1 | introduction -> assignment | | 19/03/2022, 8.13 | 19.3., 08:13 | 19.3., 09:45 |
| 2 | B | 1 | Intro->importance->example->skills->all peer experience | interested | 19/03/2022, 8.11 | | |
| 3 | C | 1 | Intro->importance->example | | 18/03/2022, 22.47 | 18.3., 22:49 | 18.3., 23:10 |
| 4 | D | 1 | Intro->importance->example->skills->all peer experience | Good | 17/03/2022, 23.32 | 19.3., 08:54 | |
| 5 | E | 1 | Assignment->Customization->Claim Reward->Intro->importance->example->skills->peer experience 1 | interested | 17/03/2022, 22.08 | 17.3., 21:40 | 17.3., 22:05 |
| 6 | F | 1 | Assignment->Intro->importance->assignment->customization ->badge->quit | | 17/03/2022,21.52 | 17.3., 20:56 | 17.3., 21:22 |
| 7 | G | 1 | Claim reward->assignment | | 17/03/2022, 16:36 | 19.3., 08:42 | 19.3., 09:13 |
| 8 | H | 1 | Customize->intro->assignment | | 16/03/2022, 00.04 | 19.3., 07:24 | |
| 9 | I | 1 | Intro->importance->example->skills->all peer experience->assignment->quit | Good | 15/03/2022,19:56 | 15.3., 20:40 | 15.3., 20:54 |
| 10 | J | 1 | topic->topic->asssignment->topic->intro->importance->example->skills gained->all peers experience->assignment->quit | Nothing | 15/03/2022, 19:53 | | |
| 11 | K | 1 | topic->intro->importance->example->skills->all peers experience->assignment | interested | 14/03/2022,22:09 | 18.3., 21:28 | 18.3., 22:35 |
| 12 | L | 1 | topic->intro->importance->example->skills->one peers experience->assignment | Curios | 14/03/2022, 21:04 | 18.3., 16:19 | 18.3., 17:19 |
| 13 | M | 1 | topic->intro->importance | | 14/03/2022, 14:40 | | |
| 14 | N | 1 | topic->intro->importance->example->skills->all peers experience->assignment->claim reward->assignment->Customization | interested | 14/03/2022 , 11:32 | 19.3., 11:21 | |

Table 8 LMS and Chatbot interaction data

Table 9 aggregates information about the interaction of the students with the chatbot. Based on the high-level data it can be observed that most students mostly accessed the topic and its significance, the claim reward, and assignment sections, and then the peer model experiences respectively in this order based on the numbers seen in the table below. The features of the

chatbot that were not often accessed were the question about the emotion of students and the customization form for personalization. Almost 57% of the interactions reached the peer model section. The least accessed section was the customization section. Please see the table below with the sections and the number of students who accessed these sections.

| Chatbot access factors | No of students |
|---|---|
| Total students took the quiz | 14 |
| Students who accessed topic information | 13 |
| students who to explore the assignment section | 12 |
| Students who claimed rewards | 12 |
| Students who did input of emotion: | 8 (7 positive, 1 neutral) |
| Students who accessed peer experiences (one or more) | 8 |
| Students who accessed customization | 3 |
| Students who did all options | 2 |

Table 9 Flippy chatbot interaction statistics

The following are the points observed from the above table: -

1. 57.14% of students accessed the quiz after the use of the chatbot. Out of these students, only 37.5% of students immediately went to access and do the quiz while 62.5% went to the quiz after a few days that is on the day of the class or one day before the class.
2. 21.42% of students who used the chatbot accessed the quiz first from Moodle and then later accessed the chatbot.
3. 21.42% of students who used the chatbot did not access the quiz on Moodle LMS.

It is seen from the above points that only a few students went to the assignment immediately after interacting with the chatbot while many students used the chatbot but did the quiz a few days later. It is also seen that some students accessed the Moodle quiz first and then immediately checked out the chatbot.

## 6.2 Interview-based survey results and Analysis

In the current research work, the chatbot is checked for its intrinsic motivation-building capabilities as the focus was to enhance the intrinsic motivation of students in the flipped class. Also, the opinions and suggestions of the students concerning the chatbot feature like peer modeling, and topic importance will be considered. The results of the evaluation and the user suggestions will help to build the existing knowledge base of the topic and help future researchers to conduct their research work on a similar topic (Hevner and Chatterjee, 2010; Carcary, 2011). In this current design science phase, the chatbot is the proof of concept or the initial design of the chatbot. The suggestions that are received by the evaluation of the results will be used in the next design science cycle to build the actual working prototype (Hevner, 2007). In the next section, the user suggestions or inputs will be considered, and new improvements will be suggested in the current proof of concept. In the context of the thesis,

evaluation is based on the application of the proof of concept to a specific case study i.e., Business Intelligence module in the Business Information System course at FHNW.

Survey-based interviews were conducted with the students who used the chatbot and who did not use the chatbot for the preparation of the *Multidimensional modeling* lesson. The chatbot group was the test group where the students interacted with the chatbot and then went to do the assignments. While the control group was the one in which students did not use the chatbot and were given the Moodle links directly by the tutor via email. A control group is usually recommended to be used along with the test group during the evaluation of new software features to remove any confirmation bias by researchers (Karnes, 2020). The test group is used to see whether the introduction of the new software did bring a positive change for users. Any change that is identified in the test group and which is not identified in the control group can be associated with the new software or product (Karnes, 2020). A comparison is usually done between the responses of the control and the test group to see the effectiveness of the new product and to reduce any error in the conclusion of the results (Karnes, 2020). The control and test group are given similar treatments except the control group doesn't use the new product (Karnes, 2020). The test group survey and interview data are qualitatively evaluated. The outcome of the surveys won't be analysed statistically as the number of participants was very small. But the point of confirmation bias is still valid for the evaluation of the thesis work. The evaluation of the chatbot is qualitative but uses experimental principles to avoid biases.
Initially, all students from the test group were contacted via email multiple times. Some students replied they were busy with their studies and could not attend the interviews. Eventually, four participants were interested to give the interview and the survey. Four participants were recruited for the same for the control group. Following was the procedure for the test group interview.

1. The total interview time was thirty minutes since students mentioned their availability for that time only as they were busy with their studies.
2. In the first five minutes of the interview, students were reminded of the chatbot interaction that they had and were given the link to see it again in case they did not remember it in detail.
3. Then they were told to fill out an online survey that had some structured and unstructured questions regarding their perceptions of the chatbot and their thoughts about the chatbot.
4. In the end, five to ten minutes were spent discussing the answers given to the open-ended questions in the survey.

For the control group, the same interview format was there except they were told to think about their experiences with the Moodle LMS where they did their homework, and a separate but similar survey focused on Moodle experience was provided to them. In normal

circumstances in the BI module, the tutor sends the email with the Moodle links for preparation before the class. But for the evaluation instead, the email of the chatbot is sent to the test group. While the control group is treated with the normal process. This distinction is done to see if there is any change/deviation in the intrinsic motivation of the test group who used the chatbot in comparison to the control group who did not use the chatbot. In the next section, we look at how the surveys were structured and the nature of the questions, and what was their goal in student evaluation.

### 6.2.1 Discussion of the scored results

The nature of the questions in the student surveys is based on the intrinsic motivation inventory (IMI) (Center for Self-Determination Theory, 2022) which recommends the use of a certain set of questions in different categories to assess the participant's intrinsic motivation concerning a certain task or activity. It provides a set of questions in different categories to assess students' perceived autonomy or choice, competency, value/usefulness, interest/enjoyment, pressure, tension, and relatedness (Center for Self-Determination Theory, 2022). The questions related to interest/enjoyment are self-reported measures in assessing the intrinsic motivation of users (Center for Self-Determination Theory, 2022). This inventory and questions have been validated by (McAuley, Duncan and Tammen, 1989) and proved to be of great value in assessing the intrinsic motivation of users (Center for Self-Determination Theory, 2022). Furthermore, it has been referenced and used in different experiments and research work by several researchers to assess intrinsic motivation (Ryan, 1982; Ryan, Mims and Koestner, 1983; Plant and Ryan, 1985; Ryan and Deci, 1987; Ryan, Connell and Plant, 1990; Deci *et al.*, 1994; Center for Self-Determination Theory, 2022).

Two different sets of similar structured statements for the control group and test group were created. One was in the context of the Moodle user and the other in terms of the Flippy chatbot user. The questions from IMI were modified to fit these two groups and the different tasks. Some questions were formed by taking points from the literature on intrinsic motivation. For the structured questions, a Likert [18] scale from 1 to 5 where 1 is for least agree and 5 is for the most agree concept was used. This was taken to give students more freedom to select their answers rather than a simple yes or no (Center for Self-Determination Theory, 2022). Following are the interpretation of the scale: - 1 least agree, 2 not that agree, 3 undecided/neutral, 4 agree, and 5 most agree. After the structured questions, more open-ended questions were asked. This will be discussed in the subsequent pages in detail. The

[18] https://www.simplypsychology.org/likert-scale.html

surveys were conducted in online software i.e., Google Forms[19]. The interviews were recorded in Webex [20] by taking prior permission from students. In the surveys, the students gave their permission to use the data for the research and thesis work.

Table 10 below gives the reference questions and their categories used from IMI and the similar questions created on its basis for the control group (Moodle or without chatbot) and test group (chatbot group) along with the results of the questions for both the surveys in Table 11. In the *Table 11*, the result of the chatbot contains values for disagree, neutral/can't say, and agree. Following is the interpretation:

a) The disagree value is for the number of students whose answer was less than 3.
b) The neutral value is for the number of students whose answer is equal to 3.
c) While the agree is for the number of students whose answer is greater than 3.

Please note that value 3 is the middle value of the Likert cell in which students are not very sure of their reply concerning the question in the survey. A similar interpretation is for the cells within the column Result of Moodle questions for the control group. The survey answers can be found in these sections in Appendix 8.4, and 8.5.

[19] Google Forms: Online Form Creator | Google Workspace
[20] Video Conferencing, Cloud Calling & Screen Sharing | Webex by Cisco

| No. | Category (Center for Self-Determination Theory, 2022). This category is concerning different aspects of the feelings of students. | IMI reference questions (Center for Self-Determination Theory, 2022). These are the reference questions from the IMI and other research papers. | Chatbot survey questions (1 is least agree, 5 is most agree). These are the questions asked in the chatbot survey | Moodle survey questions (1 is least agree, 5 is most agree). These are the questions asked in the Moodle survey |
|---|---|---|---|---|
| 1 | Perceived autonomy/choice | I believe I had some choice about doing this activity (Center for Self-Determination Theory, 2022, p. 4) | Chatbot gave me different choices to interact with and gave main highlights about the MDM topic. | I believe that Moodle gave me choices to interact with the preparation material for the MDM class |
| 2 | Perceived competency | | The interaction with the chatbot is easygoing. | It was easy to interact with Moodle with respect to preparation materials for the MDM topic |
| 3 | Perceived competency | I think I am pretty good at this activity (Center for Self-Determination Theory, 2022, p. 3). | I felt confident about my skills after interaction with chatbot | I was confident about my skills and abilities after interacting with Moodle and the preparation materials for MDM topic. |
| 4 | Interest, competency | | After hearing similar students experience about MDM topic, I was interested and confident to prepare for the topic. | NA |
| 5 | Curiosity | | After hearing about the MDM topic introduction, examples, and skills gained my curiosity to explore the topic increased | NA |
| 6 | Perceived relatedness | | NA | Moodle allows me to connect with other students and learn about their learning experiences. |
| 7 | Perceived relatedness | | The chatbot was friendly during the interaction. | The interaction with Moodle was easy |
| 8 | Perceived relatedness | | I felt inspired after learning about other similar students' experiences on the MDM topic. | I felt motivated after interacting with Moodle and learning materials to prepare for the MDM topic |
| 9 | Pressure / tension | I felt pressured while doing these (Center for Self-Determination Theory, 2022, p. 4) | I felt the pressure to do my assignment after the chatbot interaction | I felt the pressure to do my assignment after interaction with Moodle and preparation materials |

| | | | | |
|---|---|---|---|---|
| 10 | Pressure / tension | I was anxious while working on this task (Center for Self-Determination Theory, 2022, p. 4). | I felt anxious after hearing about the MDM topic and assignments after the chatbot interaction | I felt anxious after looking at preparation materials and quiz on MDM topic and assignments |
| 11 | | | NA | I did not feel the pressure to do assignment when I received email or while interacting with Moodle |
| 12 | Interest, enjoyment, curiosity | This activity was fun to do (Center for Self-Determination Theory, 2022, p. 3) | It was fun to interact with the chatbot | It was fun to interact with Moodle interface for MDM topic or for any other topic |
| 13 | Interest, enjoyment, curiosity | | I got interested in the MDM topic after interaction | I got interested in the multidimensional modeling (MDM) topic |
| 14 | Interest, enjoyment, curiosity | | I was curious and eager to read the primer and do the assignment quiz for MDM after the chatbot interaction | I was curious/eager to read the primer and do the quiz assignment for MDM topic |
| 15 | Relatedness | I would like a chance to interact with this person more often (Center for Self-Determination Theory, 2022, p. 4). | I would interact with chatbot again for another Business Intelligence topic | NA. as students will need to interact it as it hosts all materials for learning |
| 16 | Usefulness/value | I think this is an important activity (Center for Self-Determination Theory, 2022, p. 4) | I got an impression after interaction with chatbot that the MDM topic is an important topic for my professional and academic growth | After going through preparation materials on Moodle, I thought that the MDM topic is important for my academic and professional success |
| 17 | Effort/importance | | I interacted well with the chatbot. (I went through almost all the options/choices provided) | I interacted thoroughly with Moodle and preparation materials for MDM topic. |
| 18 | Usefulness/value | I believe this activity could be of some value to me (Center for Self-Determination Theory, 2022, p. 4). | I felt the need to put efforts in the MDM topic preparation and quiz after knowing about its importance from other students | I felt the need to put effort into the MDM home assignments (primer and quiz) |

Table 10 Survey questionnaire and results for Moodle and Chatbot Groups

| Question Number | Emotional need | Flippy Values | | | Moodle values | | |
|---|---|---|---|---|---|---|---|
| | | Disagree | Neutral/Can't Say | Agree | Disagree | Neutral/Can't Say | Agree |
| 1 | Perceived autonomy/choice | 1 | | 3 | | | 4 |
| 2 | Perceived competency | 1 | | 3 | | 1 | 3 |
| 3 | Perceived competency | 2 | 1 | 1 | | 4 | |
| 4 | Interest, competency | | 2 | 2 | | | |
| 5 | Curiosity | 1 | 1 | 2 | | | |
| 6 | Perceived relatedness | | | | 3 | 1 | |
| 7 | Perceived relatedness | | | 4 | | 1 | 3 |
| 8 | Perceived relatedness | 1 | 1 | 2 | | 1 | 3 |
| 9 | Pressure / tension | 3 | 1 | | 2 | 1 | 1 |
| 10 | Pressure / tension | 4 | | | 1 | 1 | 2 |
| 11 | Pressure / tension | | | | | 1 | 3 |
| 12 | Interest, enjoyment, curiosity | 1 | 1 | 2 | | 2 | 2 |
| 13 | Interest, enjoyment, curiosity | 1 | 1 | 2 | 1 | 1 | 2 |
| 14 | Interest, enjoyment, curiosity | 1 | 1 | 2 | 1 | | 3 |
| 15 | Relatedness | 1 | 1 | 2 | | | |
| 16 | Usefulness/value | 2 | 1 | 1 | | 2 | 2 |
| 17 | Effort/importance | 1 | | 3 | 1 | 1 | 2 |
| 18 | Usefulness/value | 1 | 2 | 1 | | | 4 |

Table 11 : Comparison of Flippy versus Moodle survey ratings

Following is the analysis of the above questions in the Table 10 and their ratings in Table 11. The values above three are considered to have an agreeable trend while less than three are on the not agreeable trend. While three is undecided or can't say trend: -

- The first-row questions were asked to know whether Chatbot and Moodle gave them sufficient choices/options and freedom for doing the assignment and exploring the preparation material at their own pace and time. We know from the literature review that giving choices to students while learning imparts the feeling of autonomy. As compared to Flippy, more students (+1) perceived Moodle as giving more learning choices.
- Second-row questions check the competency of the students while handling the respective apps. This competency is for the ability to use the application. Seventy-five percent of students (3) show a tendency to agree (>3) feel competent/capable to handle both apps equally.
- In the third-row questions, the students are asked if they feel confident about their skills concerning the MDM topic after interacting with the respective apps. As compared to Moodle, only one student shows a tendency to agree (>3) for being confident about their skills after using Flippy. For Moodle, all students show uncertainty about their confidence.
- In questions in row four, the questions are asked whether students felt confident and interested to learn about the MDM topic after learning about students' experiences delivered by Flippy. Confidence indicates high self-belief (competency), and interest shows intrinsic motivation (M. Ryan and L. Deci, 2000; Muir, 2018). This question was asked only to the chatbot group as peer modeling is not found in Moodle. Fifty percent of students (2) show a tendency to agree (>3) for showing confidence and interest in the topic after learning about students' experience with the MDM topic from Flippy.
- Fifty percent of students (2) show a tendency to agree (>3) for being curious about the topic after knowing its importance from Flippy (row 6).
- In row six, a question about whether Moodle allows connecting with other students was asked. Relatedness concerning group activities builds relatedness in students(Trenshaw *et al.*, 2016). Most students (3) show a tendency to not agree (<3) concerning the connection with other students via Moodle.
- Relatedness is also connecting with the chatbot at an emotional level. In row seven, students were asked about their friendliness with Flippy and similarly how easy-going it was with the Moodle interface. As compared to Moodle, more (+1) students (s) show a tendency to agree (>3) concerning friendliness/easy-going with Flippy.
- In row eight, students were asked for Flippy whether they were inspired after learning students' experiences (peer models) about the MDM topic. For Moodle, students were asked if they felt motivated to prepare for MDM after interacting with the materials and

the apps. As compared to Flippy, more students (+1) show a tendency to agree (>3) with Moodle concerning getting motivated to learn about the MDM topic.

- In row nine, students were asked if they felt pressure to do the assignment after interacting with the chatbot and Moodle respectively. Any form of external control diminishes autonomy and impacts intrinsic motivation(M. Ryan and L. Deci, 2000). As compared to Flippy, more students (+1) show a tendency to agree (>3) for Moodle concerning getting pressurized to do an assignment after the interaction. For Flippy, most students show a tendency to not agree (< 3) or to feel pressure to do an assignment after the interaction.
- In row ten, students were asked if they felt anxious after interacting with the chatbot and respectively the group for Moodle. Any form of fear undermines intrinsic motivation(M. Ryan and L. Deci, 2000). As compared to Flippy, more students (+2) show a tendency to agree (>3) with Moodle concerning getting anxious about the learning topic after the interaction. For Flippy, all students show a tendency to not agree with getting anxious after the interaction.
- In row eleven, for Moodle, 3 students don't feel pressure while using it during initial interactions.
- In row twelve, the question for Flippy and Moodle is asked whether students found the interaction with their respective apps a fun activity. Fun-filled activities indicate intrinsic motivation (M. Ryan and L. Deci, 2000). Only 2 students show a tendency to agree (>3) concerning friendliness and being easy-going with both apps equally.
- In row thirteen, the questions for Flippy and Moodle are asked whether students found interest in the MDM topic after respective interactions. We can see that only 2 students show a tendency to agree (>3) regarding their interest in the MDM topic in both cases after using both apps.
- In row fourteen, the questions for Flippy and Moodle are asked whether students found curiosity in the MDM topic after respective interactions. As compared to Flippy, more students (+1) show a tendency to agree (>3) with Moodle concerning getting curious about the learning topic after the interaction.
- In row fifteen, students who used Flippy were asked if they would use it another time for another time. Two students answered more than average, while 1 gave = average and 1 less than average. We can see that only 2 students want to use Flippy next time.
- The value/usefulness is an important category because if students feel that an activity is useful for them then they internalize it and perform it (Deci *et al.*, 1994; Center for Self-Determination Theory, 2022). In row sixteen, students were asked if after their interaction with their respective chatbots, they found MDM topics important for their academic and professional success. As compared to Flippy, more students (+1) show a tendency to agree (>3) that they perceived the topic as important for professional and academic growth after

interacting with materials on Moodle. As compared to Flippy, more students (+3) show a tendency to agree (>3) that they feel the need to prepare well after interacting with materials on Moodle.

- Concerning row number seventeen question students were asked if they interacted well with their respective apps. As compared to Moodle, more students (+1) show a tendency to agree (>3) that they interacted well with the Flippy chatbot.

### 6.2.2 Important highlights from the survey results.

In this subsection, the thesis presents the summary of those results which shows an impact on the different emotions of the given sample of students concerning intrinsic motivation. Table 12 above gives the main important highlights of the results discussed in detail in the previous section. The table provides the category of the questions, results, and the number of students in each range of scoring. In the given sample data (4 chatbot students, and 4 Moodle students) we don't see variations in the student data concerning the perceived choice, perceived relatedness, and interest and curiosity between the two groups. Impact in the categories of perceived competency concerning the MDM topic, pressure and anxiety concerning the MDM topic, and *usefulness* value can be seen in the different rows. The rating for each category of questions can be referred from Table 11.

| Category | Results |
|---|---|
| The perceived choices concerning the MDM topic | As compared to Flippy, more students (+1) perceived Moodle as giving more learning choices. |
| Perceived competency concerning the MDM topic | As compared to Moodle, one student shows a tendency to agree (>3) for being confident about their skills after using Flippy. For Moodle, all students show uncertainty about confidence concerning their skills in the MDM topic. |
| | 1. Fifty percent of students (2) show a tendency to agree (>3) for showing confidence and interest in the topic after learning about students' experience with the MDM topic from Flippy.<br>2. Fifty percent of students (2) show a tendency to agree (>3) for being curious about the topic after knowing its importance from Flippy. |
| Perceived relatedness concerning the MDM topic | As compared to Flippy, more students (+1) show a tendency to agree (>3) with Moodle concerning getting motivated to learn about the MDM topic. |
| Relatedness concerning the use of respective apps. | All students in the chatbot show tendency to agree (>3) that the interaction with Flippy was friendly.<br>On the other hand, only 3 students show a tendency to agree (>3) that the interaction with Moodle was easy |
| Interest, enjoyment, curiosity concerning the MDM topic | 1. We can see that only 50% of students show a tendency to agree (>3) regarding their interest in the MDM topic in both cases after using both apps.<br>2. As compared to Flippy, more students (+1) show a tendency to agree (>3) with Moodle concerning getting curious about the learning topic after the interaction. |
| Pressure, anxiety concerning the MDM topic | 1. As compared to Flippy, more students (+1) show a tendency to agree (>3) for getting pressurized to do an assignment after the Moodle interaction. For Flippy, most students show a tendency to not agree (< 3) for feeling the pressure to do the MDM assignment after the interaction.<br>2. As compared to Flippy, more students (+2) show a tendency to agree (>3) about getting anxious about the learning topic after the Moodle interaction. For Flippy, all students show a tendency to not agree with getting anxious after the interaction. |
| Usefulness value | As compared to Flippy, more students (+3) show a tendency to *agree* (>3) that they feel the need to prepare well after interacting with materials on Moodle. |

Table 12 Results comparison of Moodle and chatbot groups

### 6.2.3 Results of the open questions

In the surveys, some open questions were asked to see the opinion of the students. Four students took part in the survey from the test group. They were also clarified in the interviews. A follow-up survey was also conducted with the students from the test group to know their opinion about peer modeling (PM) and the factor "Explain the importance of learning topics" (EILT). Following are the questions and student answers: -

1. The chatbot interaction was useful for: -
   - getting more insights about the topic in an interactive manner.
   - easy access and structured suggestives
   - Video of example application
   - Getting the initial idea what is MDM about (topic was completely new for me)

   Four students responded to question 1.

2. Which features do you most like in the chatbot?
   - A suggestive approach that can provide timely and easy access to information.
   - Video about application
   - 1) students' experiences 2) combination of text, video 3) possibility to select which way to approach the topic (what to read first)

   Three students responded to question 2.

   What would they like to improve in the chatbot? Any other feedback or opinion concerning chatbot features? Four students responded to question 2. Please refer to table 13 below for the student's answers.

| Answer from survey | Detailed reasons from the interview |
|---|---|
| going back and forth between the topics was a bit tedious - would be nicer to have the "menue" above always available. Having the chance to write a question would be excellent. Otherwhise I was happy | • The student prefers a static menu on the chatbot, where she can select and move ahead rather than receiving buttons on every response.<br>• The student liked the concept of the peer model experiences and the idea of customizing the experience for similar peer model recommendations. The student could relate to their experiences.<br>• The student would also prefer to ask questions to the chatbot related to the preparation and topic content. |

| | |
|---|---|
| 1) more information about the topic in the beginning / more content 2) more intelligent chatbot (understand larger variety of vocabulary) | • Student prefers experiences of similar as well as different background as well.<br>• Students would prefer more basic examples and basic concepts to be told by the chatbot as the student is from a non-technical background and was new to the topic.<br>• the student liked the idea of having the gamification concept of rewards and thought it was fun and motivating.<br>• The student prefers to have some error handling in the chatbot. The student clicked on the button and an error came. Then the chatbot should be capable to handle this well.<br>• The student preferred to use the chatbot for other topics as well.<br>• The student would prefer to use a chatbot for important topics. |
| It's not very practical. Reading a PDF would be easier. Just clicking for the next "junk" of text was cumbersome. After restarting I had to start from the beginning. I'm not really seeing the added value compared to a text document with some videos linked. | • The student did not find the chatbot practical.<br>• The student left the chatbot in between and then came back again. The student had to refresh the chatbot. The student prefers the option to go back to where he left.<br>• The student prefers to read the bigger text and a video for content.<br>• The student was already motivated to go through the topic on LMS and did not feel like using a chatbot for getting interested.<br>• The student would like to have a video at the start for peer experiences. |
| Well, the idea is futuristic...a repository for a chosen topic would be helpful with literature and video links. | The student would like to have some repository in the chatbot that gives links to additional optional preparation materials. |

Table 13 Student-suggested features/improvements in Flippy

I found that three out of four students gave positive feedback for Flippy while one student gave negative feedback. This student did not find it useful to use Flippy as he preferred to read pdf with more details than a chatbot. This student had sufficient knowledge and technical background required for the topic and was already motivated to learn the MDM topic. He also had work experience and seem to be technically sound. The chatbot did not serve his purpose as he was already interested in the topic. While another student had a non-technical

background and preferred to use the chatbot next time since she liked to see basic concepts in small text rather than long text with more examples. Another second survey was conducted to get feedback from students concerning PM and EILT factors. Only two students took the survey from the test group. The following questions were asked: -

1. In the Flippy chatbot, the students' experiences about the MDM topic were delivered via video and text. How did you find the experiences of the students delivered via the chatbot interface? (Overall user experience)
    - Nice to get to know more about other experiences of former students. Due to time constraint I did not watch all the videos until the end.
    - Video was really good. Text was also good, but video was nicer.

2. Do you think the past experiences of students will help you in your preparation for the topic of MDM? Please explain in 1-2 sentences.
    - It is a fresh and different way to prepare for a topic. However it was a bit a pitty that you still have to read the primers, do the quiz etc. Especially for part time students - I am not sure h 1w much time people are willing to spend additionally on a chatbot since the primers are already intense themselves. Maybe students explaining the content of the primer in the videos could be a good approach to help students (or part of its content so that u dont need to read the whole primer).
    - Hearing students experiences helps to stay motivated.

3. What other things you would like to hear from the past students about MDM or any other Business intelligence topic? How will that help you to be motivated and prepare BI topics?
    - see above
    - I would like to hear what the students are doing now and how the BI topis have helped them in their jobs.

<u>In question 6 above the first answer (see above) points to the student's answer in question 5 (first answer. The user points this out as an answer to question 6 as well.</u>

4. The chatbot, Flippy also explained the following: 1) Importance of the topic. 2) Examples of real-world usage of MDM. 3) Skills gained and how these skills will help the student? What do you think about these features delivered via the chatbot? How was your overall user experience?
    - This was value added! since the primers of the other BI lectures do not give such kind of insights it helped much to get the connection to the real-world
    - User experience was good and content also.

The following open-ended question was asked in the Moodle group survey. Four students took the Moodle survey and all of them answered the open-ended questions.
The students were told to rate on a scale of 1 to 5 the usefulness of Moodle LMS. After rating, they had to answer the following question.

1. What is the reason for the selection of value for the above question? following are the exact student answers: -
   - Moodle is well structured and has a web-interface as well as an App. It easy to navigate and find resources. Also, I like that it remains available after completion of the module.
   - I like to use quizzes after reading the materials for preparation, it helps me to fix the knowledge I've gotten during the reading. Personally I find this multi choice questions quite useful
   - It feels overwhelming most of the time. It's a pity it does not show anymore the structure of the class after opening a file from a class.
   - easy to navigate and straight forward results

2. "What would you like to improve about the Moodle experience for the preparation of various topics? Please give your opinion". Please refer to Table 13 below for their feedback about Moodle.

| |
|---|
| -maybe the chapter distribution of particular modules could be better shown/designed --> sometimes I have a feeling that the lecturers are also overwhelmed by the moodle structure and just upload all files they have which is not supportive for the learning process - maybe reduce the chapter section and place e.g. links and useful documents on the **side** of the display and highlight the most important documents |
| I would like to have more examples and practical questions, maybe more different forms of questions/in form of gamification maybe. I would like to get more impression how the information I've gotten can be used on practice and during the preparation process I would like to have various types of questions just to make the process more existing |
| Please note that for 1st question, I selected "After MDM class" because I didn't manage to finish the whole preparation before class. I would prefer video information rather than reading primers. I don't like self-study too much especially when resource is very long and sometimes complex. Therefore, I would expect a summary of the main key points as a reading. The full primer should remain available to deepen my knowledge if I want to. The quizzes are a good way to test our knowledge, but in case of wrong answers the correct ones should be explained in a detailed way. Otherwise, it is difficult for me to understand why I made something wrong. |
| Some parts like exercise part should mention maybe in the title the amount of other links or files that will be there ( or they should be visible in points before clicking on the exercise). |

Table 14 Student suggestions for improvement of Moodle

In general, students did not like the information overload in the Moodle structure. They mentioned in the interviews as well that they got overwhelmed and anxious after looking at the preparation content and Moodle structures with a lot of links and files. Also, the

preparation materials in the files were quite long and complex. They would rather prefer videos with content and some gamification for learning. Also, more practice questions or examples would help. Also, in the case of quizzes, the rationale for right-wrong answers should be provided. These points in the above question confirm our previous findings from student surveys that students do get overwhelmed by too much content on the Moodle LMS. They would like to have videos for preparation and only keep the primers or the pdf materials optional.

The interviews of the students in the chatbot test group are recorded textually in Appendix section 8.7.

### 6.2.4 High-level summary of the interview results

This subsection provides a high-level summary with an analysis of the interview and survey results of the chatbot group. They include the feedback of the Flippy chatbot concerning its features and the user experience. It includes students' opinions about the chatbot and contains suggestions for improvement given by the students related to some features. Figure 64 includes the different aspects of the results which are grouped based on their categories and depicted in different colours: -

1. Following were the features of the Flippy chatbot liked by students as observed during student surveys and interviews. These are summarized in the yellow elements in Figure 64.

✓ The interactive and easily accessible nature of the chatbot
✓ Possibility to select the approach for the navigation. This point is related to autonomy or giving choices to students while learning.
✓ Videos embedded in the chatbot with students' experiences.
✓ The idea of getting the basic concepts concisely with examples from the chatbot.
✓ The idea of having the gamification concept of rewards and thought it was fun and motivating.

2) Students liked the concept of peer modeling. These are summarized in the teal blue elements in Figure 64. Following were their opinions on it.

✓ One student liked the concept of the peer model experiences and the idea of customizing the experience for similar peer model recommendations.
✓ Students liked the combination of text and video. Half of the students liked the video examples of the peer model.

- ✓ One student would like to know what past students are doing and how the BI concepts helped them in their job. The same student thought that peer experiences helped students for getting motivated in their learning.

3) There were some suggestions from students concerning the peer modeling feature. These are summarized in the teal blue elements in Figure 64

- ✓ One could not go through the end of the video due to a lack of time.
- ✓ It would be an additional effort to go through the chatbot and then the preparation materials. To solve this, the student preferred that the material content from the preparation materials could be explained by the peer modeling video via chatbot.
- ✓ A student preferred the experiences of students with diverse backgrounds. This student also suggested that it will be good to use the chatbot for important topics.

4) Concerning the explanation of the importance of learning topics following were the positive thoughts of the students. These are summarized in the dark gray elements in Figure 64:-

- ✓ The importance of the topic, with real-world examples and skills, gained helped them to connect with the real world.
- ✓ It added a fresh and different perspective.
- ✓ It added value to their learning as this perspective was not explained in the preparation materials.

5) Following were some opinions of the students concerning the features of the chatbot that they found not so appealing.

- ✓ One student found it cumbersome to go back and forth in Flippy using navigation buttons.
- ✓ Another student preferred to use longer texts from pdf and did not feel necessary to use a chatbot for his preparation. This is because he had a technical background in the MDM topic and the student said that he was already motivated to read the preparation materials from the learning management system.

6) Following were some suggestions given by students to improve the chatbot experience.

- ✓ One student suggested showing a static menu on top which allows her to go back and forth within the chatbot. This student also suggested that Flippy could also allow taking user questions concerning topics and the preparation materials.
- ✓ Another student suggested using peer experiences at the start of the interaction rather than at the end.
- ✓ Another student suggested showing more examples of basic concepts since the student was new to the topic, and it will help to understand it better than the detailed preparation materials.

- ✓ Another student suggested having a repository of links to optional reading materials which the chatbot could recommend as good to read.

7) Based on the analysis of the surveys/interviews students who are having a less technical background or different backgrounds concerning the BI topic would prefer to use the chatbot as it delivers concise basic concepts and examples to the students. Both the students who liked the features of Flippy were from Business Administration backgrounds and had less knowledge about the BI topics.

8) It is observed from the survey that students who already have some technical background in the topic may not prefer to use Flippy as they are already motivated to read the preparation materials from Moodle.

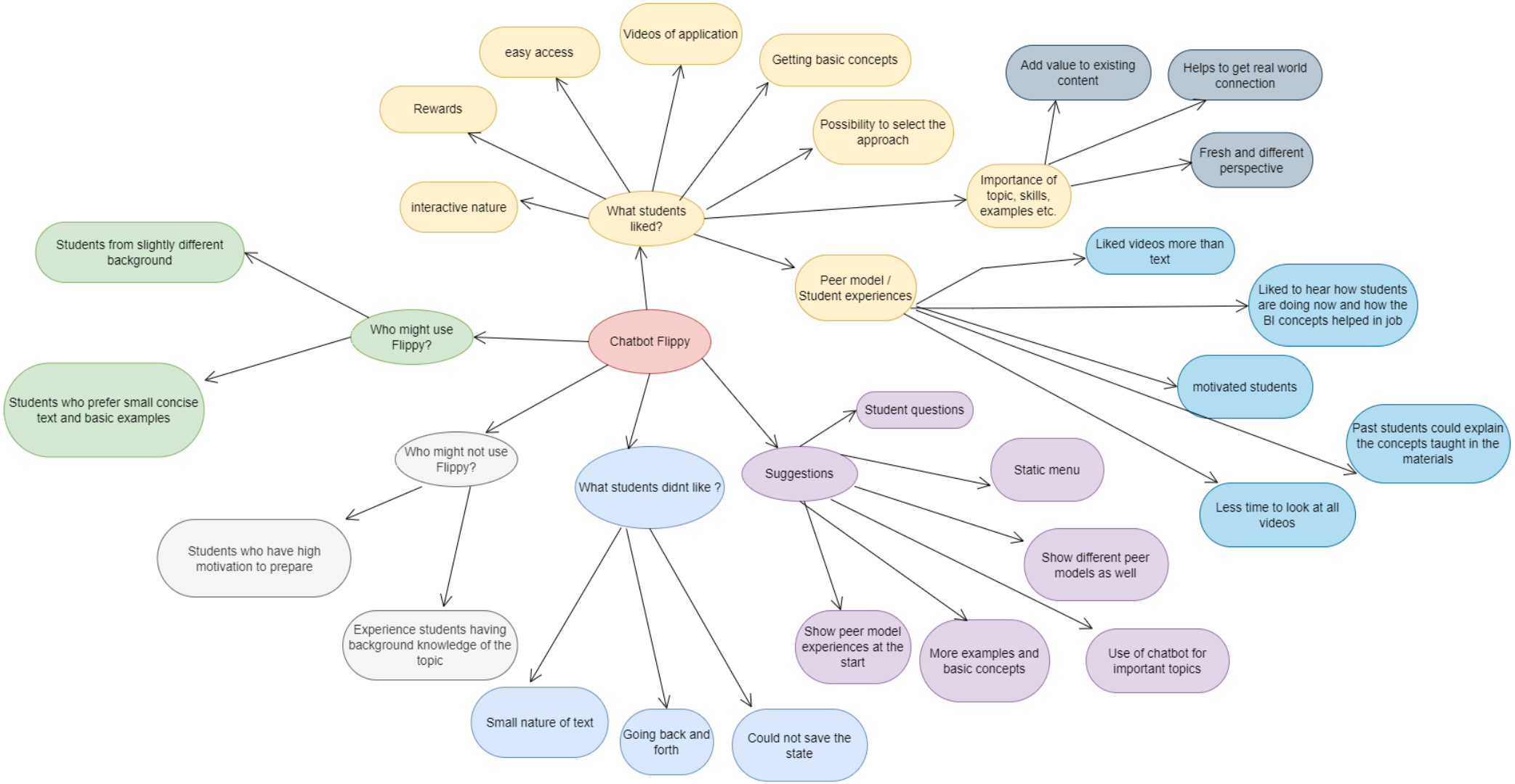



Figure 64 High-level summary of the results for Flippy

## 6.3 Chatbot testing in a large classroom setting.

### 6.3.1 Numerical results

The flippy chatbot was again introduced in the classroom of Business Intelligence class in the autumn semester of 2022. The Flippy chatbot was tested with the students of the class on a multi-dimensional modeling topic. After the end of the interaction, the students were asked to fill out a questionnaire like the previous semester in (6.2.1). Following is the result of the data analysis of the responses of **forty-three students**. The responses of the students were taken based on the Likert scale where 1 is least agree, 2 is not that agree, 3 is undecided/neutral, 4 agree, and 5 most agree.

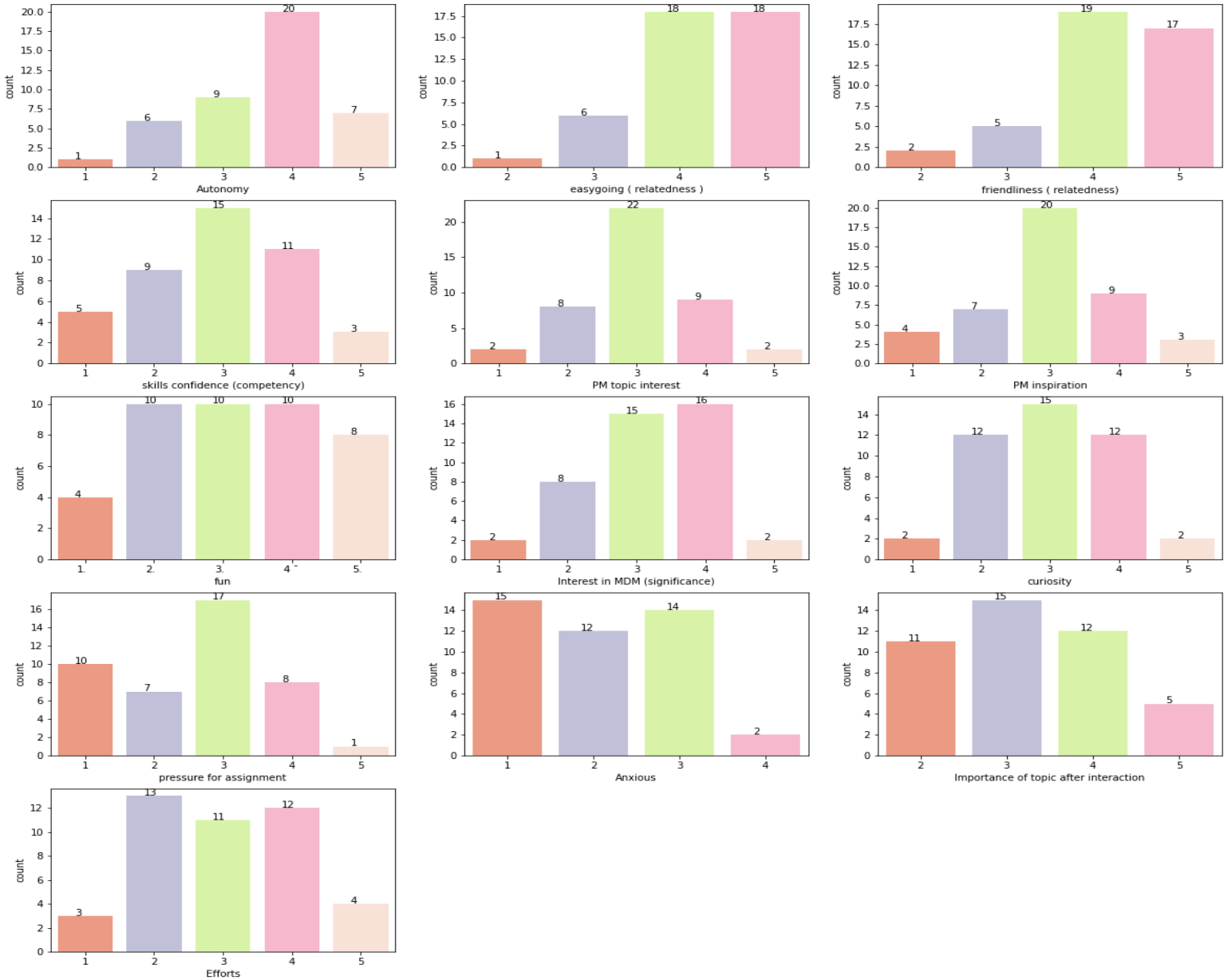





Figure 65 : Bar chart of student emotional needs with ratings found in the survey.

For calculating the trends, values > 3 are considered as agree and values < 3 are considered as not agree while values = 3 as neutral. The bar graphs for each emotional need category of students are plotted for the frequency of the ratings. In Figure 65 following are the important observations: -

1. For the autonomy category, 63% of students agree that the chatbot provided them with autonomy to explore the learning topic. Autonomy is concerning the flexibility that the chatbot provides for exploring the learning topic.
2. For relatedness with the chatbot, almost 84% of students felt that the chatbot was friendly. Almost 84% of students felt that the interaction with the chatbot was easy-going.
3. For categories related to competency after watching peer experiences and overall chatbot interaction:
    - Around 32% of students felt confident about their skills after interaction with the chatbot, while 35% of students felt neutral and around 33% did not feel confident.
    - Only 26% felt interested and confident to prepare for the MDM topic after hearing about peer model experiences. Around 51% were neutral while another 23% said they didn't feel interested and confident to prepare for the MDM topic.
    - Nearly 28% of students felt inspired to study the MDM topic after learning about similar students' experiences while around 46.5% of students were neutral and another 25.5% of students were not inspired to study the topic.
        - *It is known from Self-Determination Theory that feelings of ARC promote the feeling of intrinsic motivation* (M. Ryan and L. Deci, 2000; Deci and Ryan, 2008; Trenshaw *et al.*, 2016). *We can see that in point 1,2,3 the chatbot scored more in feelings of autonomy and relatedness. Relatively few students agreed to experience the feelings of competency from peer model experiences.*
4. Concerning intrinsic motivation around 43% of students felt that the interaction was fun, 24% of students were neutral and 33% did not find the interaction to be fun. Around 42% of students felt interested in the MDM topic after chatbot interaction, while around 35% of students felt neutral while 23% of students did not feel interested in the MDM topic. Around 32.5% of students felt curious to read the primer and do the assignment after chatbot interaction. While another 35% of students felt neutral. Another 32.5% of students did not feel curious to read the primer and do the MDM assignment.
    - *It is seen in literature that feelings of curiosity, fun/enjoyment, and interest indicate the presence of intrinsic motivation. Interest in an activity or task is an indicator of intrinsic motivation* (Harackiewicz, 1979; Ryan, 1982; Deci and Ryan, 1985; M. Ryan and L. Deci, 2000). *Student ratings were relatively more for interest and fun as compared to the curiosity category. Hence, we can conclude that many students in*

*the flipped class were intrinsically motivated to interact with the chatbot and to learn about the MDM topic.*

5. Around 39.5% of students did not agree that they felt pressure to do the assignment after chatbot interaction, while another 39.5% felt neutral. While 21% of students felt the pressure to do the assignment after chatbot interaction. Almost 63% of students did not agree that they felt anxious to do the assignment after chatbot interaction, while another 32% felt neutral. While nearly 5% of students felt the anxiousness to do the assignment after chatbot interaction.
    - *Some students felt pressurized and anxious concerning the MDM topic and its assignments during chatbot interactions. It is observed from the literature that negative feelings like pressure and anxiety undermine intrinsic motivation among students* (Reeve and Deci, 1996; M. Ryan and L. Deci, 2000a; Sun, Syu and Lin, 2017). *But the students who felt the negative feelings were less as compared to those who didn't feel them or those who were neutral.*
6. Around 39% of students felt that the MDM topic is important to study after chatbot interaction. While another 35% of students felt neutral. Another 26% of students did not feel that the MDM topic is important to study. Almost 37% of students felt the need to put effort to study MDM topics after chatbot interaction. While another 26% of students felt neutral. Another 37% of students did not feel that the MDM topic is important to study.
    - *It is seen that many students felt that the MDM topic was important for their learning after chatbot interactions and decided that they would put effort to prepare for the topic. This will help the students to study the topic autonomously rather than under external pressure or influence and make their learning more self-regulated.*

Please note in the count plots in Figure 65, 66 if the count of some category is zero then the category is not displayed in the graph. In the appendix section 8.13 other visualizations are used for graphs in Figure 65 and 66.

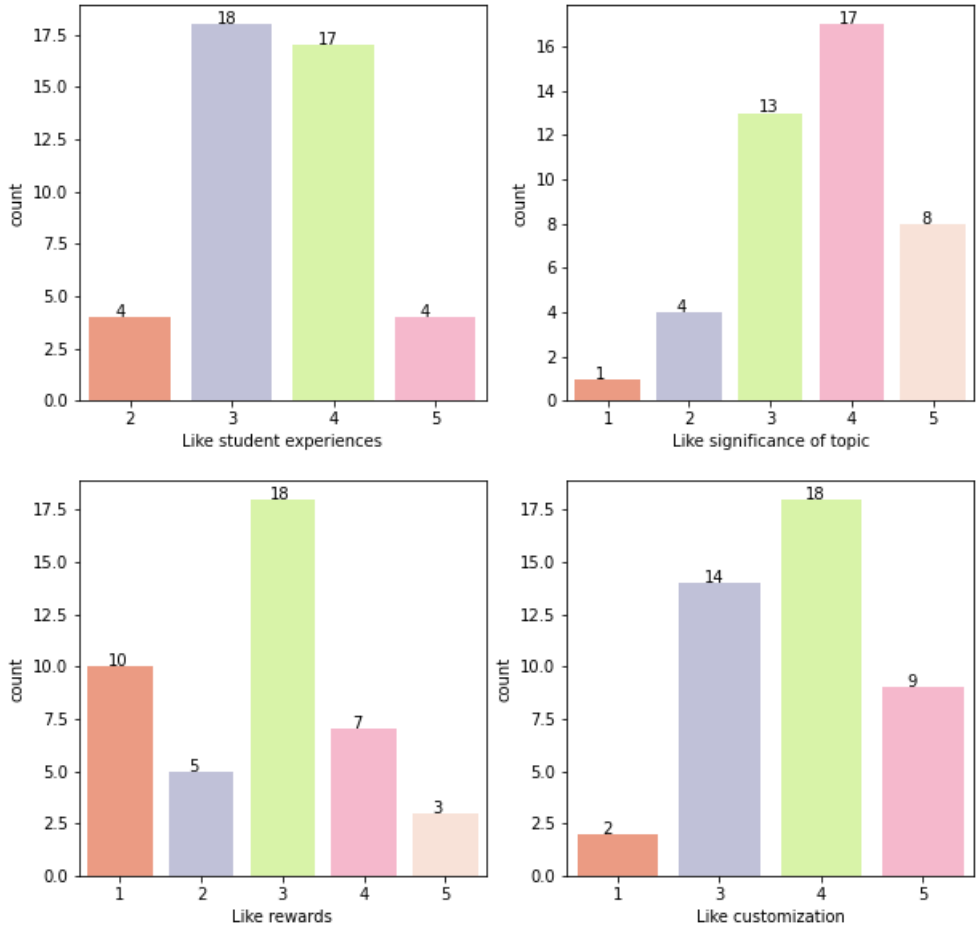



Figure 66: Bar graphs for different chatbot features.

Students were asked to rate the peer modeling, the significance of the topic, rewards, and customization. Please refer the Figure 66 above. The following are the results: -

1. 49% of students liked the peer experiences delivered by the chatbot (video and text both), while 42% of students were neutral. While 9% of students did not like the student experiences delivered by the chatbot.
2. 58% of students liked the significance of the topic delivered by the chatbot. While 30% of students felt neutral. Nearly 12% of students did not like the significance of topic features in the chatbot. These include 1) the Importance of the topic. 2) Examples of real-world usage of MDM. 3) Skills gained and how these skills will help the student
3. Only 23 % of students liked the rewards section, 42% of students were neutral and 35% of students did not like the rewards section.

4. 63% of students liked the customization section, 32% of students were neutral and 5% of students did not like it.

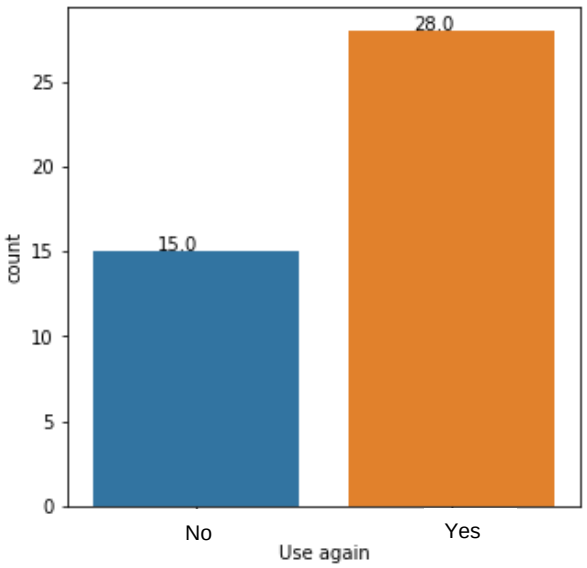



Figure 67: Students use the chatbot again.

Students were asked if they would use the chatbot again and 65% of students said that they would use it. While 35% of students said that they won't use it next time. Please refer to Figure 67 above for students' reply with counts.

### 6.3.2 Qualitative results

The students were asked more qualitative questions related to the different features of the chatbot and why they liked / not liked certain features of the chatbot. The questions and answers in details are given in detail in Appendix section 8.9.

The students were asked if they would use the chatbot next time and the reason for their answer. Please refer to image 68 below as it gives the reasons why students prefer to use and not use the chatbot in the future. The most observed trends/topics are selected from the student's comments for such an analysis.

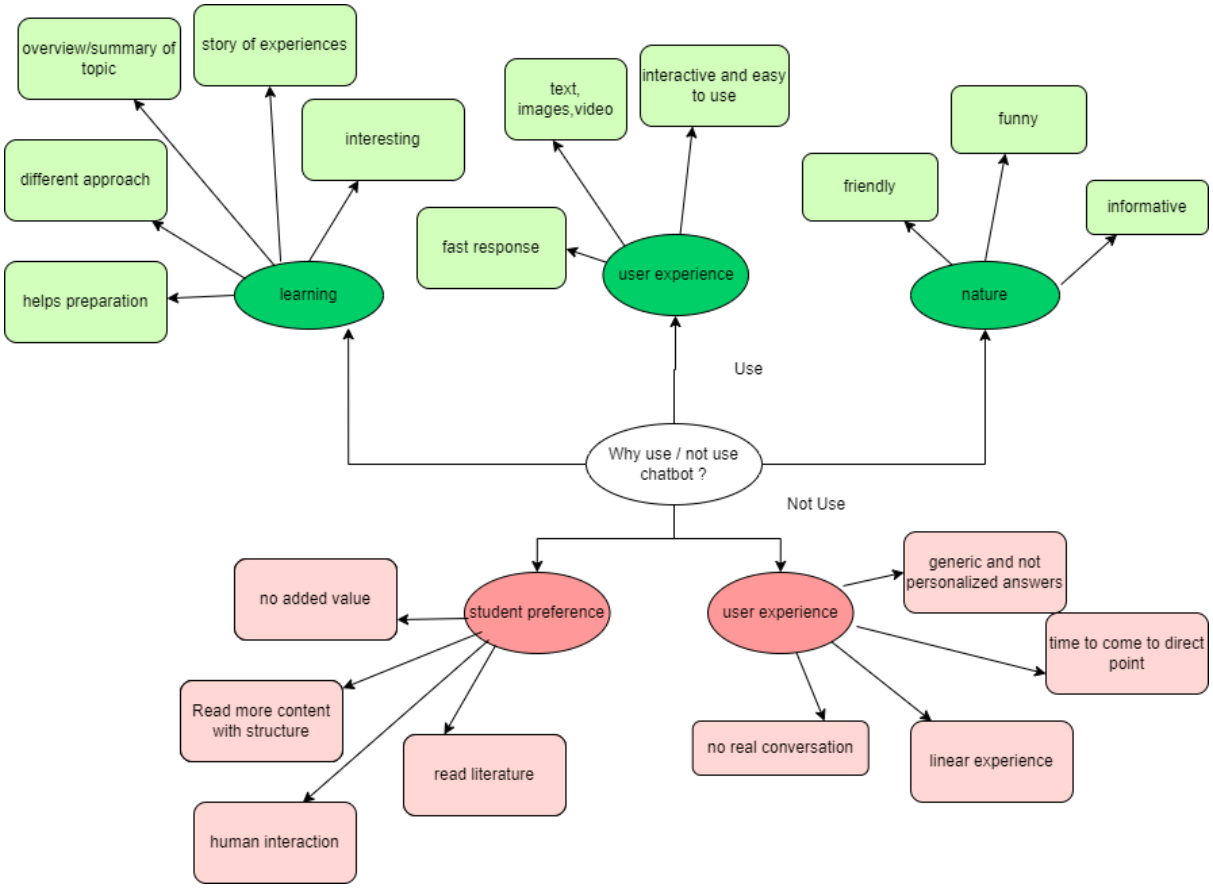



Figure 68 Student reasons for using/not using a chatbot in the future.

It is observed from student comments that many students preferred to use the chatbot next time in the future due to the following reasons: -

1. Learning: Students thought that the chatbot was helpful in the preparation and employed a unique approach to learning. The chatbot was interesting and gave a quick summary of the main points of the topic. Also, they found the story of student experiences (peer model) interesting.
2. User experiences: Students liked the interactive and fast response of the chatbot. They liked the text and image and video variety in the content of the chatbot.
3. Nature: Students liked the funny, informative, and friendly nature of the chatbot.

It is observed from student comments some of them preferred to not use the chatbot due to the following reasons: -

1. Student preferences: Students thought that the chatbot did not add any value to learning. Some would prefer to read literature and more content from books. Some students preferred to read the pdf primer provided with the homework as it was detailed with more text. While other students prefer human interaction for learning.
2. User experience: students thought that it took time to reach the direct content in the chatbot. Some thought that experience was mostly linear, and they would prefer to read from pdf files. Some would prefer more real conversations and prefer to ask colleagues or

teachers. Some thought the chatbot provided generic answers and were not personalized based on students' preferences.

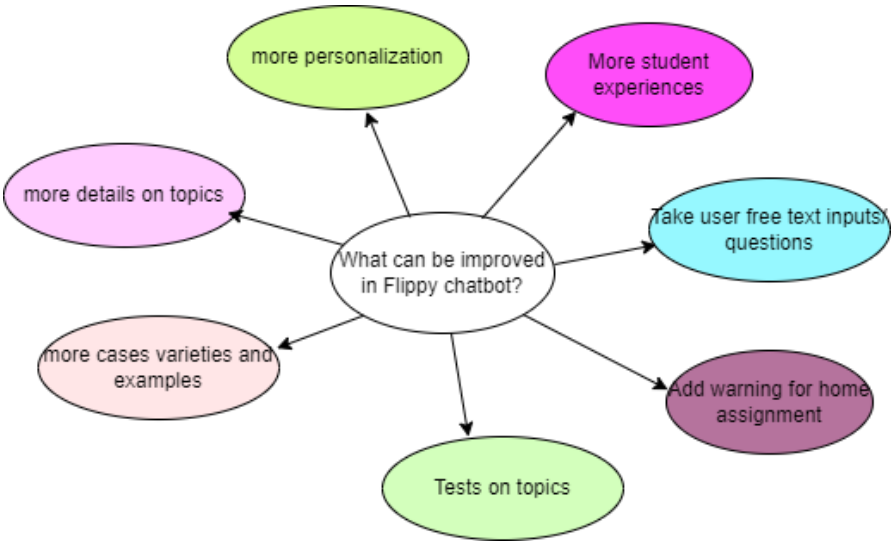



Figure 69: What needs to be improved in the Flippy chatbot?

Students were asked what they would like to improve in the Flippy chatbot. Following were some of the common trends found in the comments (Refer to Figure 69). Some students expected more details on the learning topics and more examples and case varieties along with more student experiences in the chatbot. Also, some students expected a feature to ask questions to the chatbot and get precise and detailed answers. Some students expected that chatbots could conduct tests concerning the learning topic. Also, the chatbot could present some warning to students along with the time required to complete the homework when they enter the chatbot engagement. Also, some students demanded a more personalized experience.

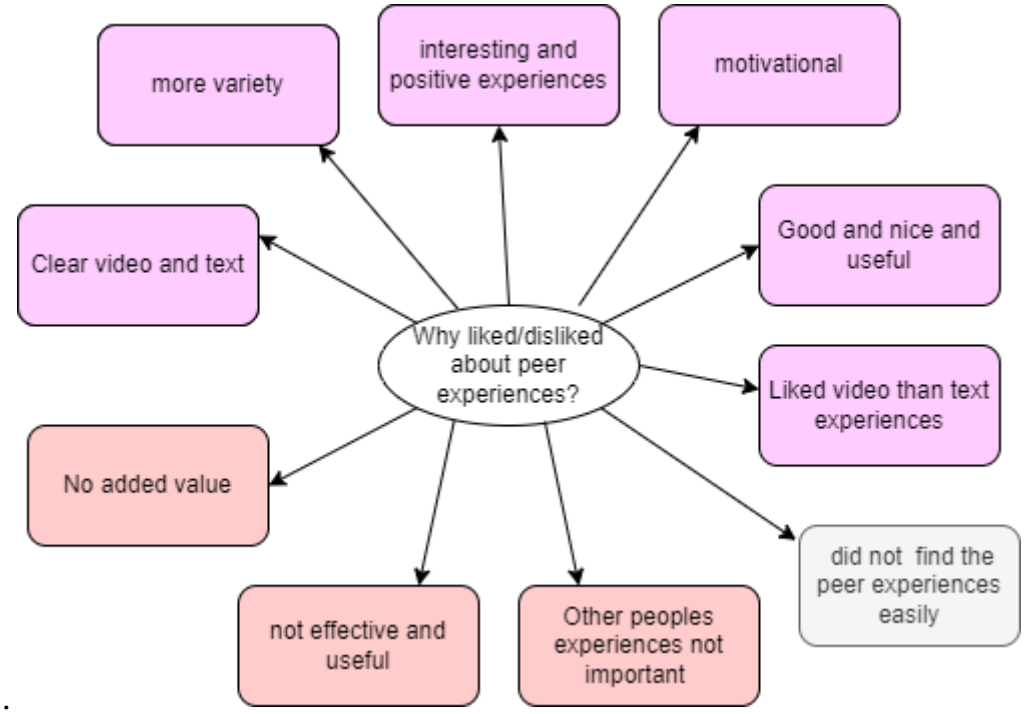



Figure 70: Students' thoughts on why they liked/disliked peer experiences.

Almost **fifty percent** of students went until the peer modeling section as per the information in the logs. Some students were not clear on the flow of the chatbot and did not reach the point of peer modeling. Overall, there are **twenty – two** positive student comments for peer modeling together coming from this question and other questions in the same survey. There were **three** negative student comments concerning peer modeling. Students thought peer modeling experiences as nice, useful, and good for their learning. Some students thought they were positive, interesting, and motivating to know students' experiences. Students liked the variety the chatbot provided along with text and video examples of peer experiences. Students seemed to like the use of video more than the text in peer modeling experiences. Concerning the negative comments, some students felt that the peer experiences didn't add any value to their learning and were not effective and useful at all. Some students thought that other students' experiences were not important. Refer to Figure 70 for the important themes concerning peer modeling.

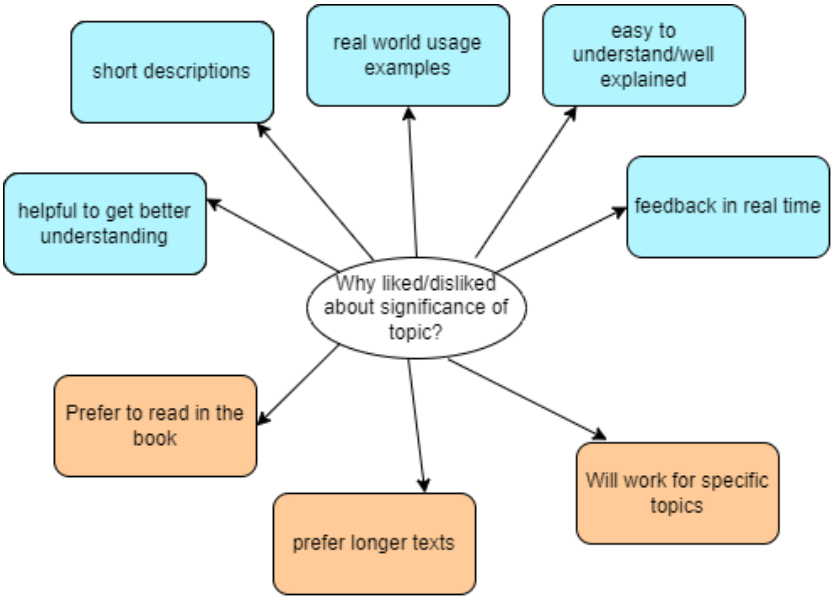



Figure 71 Students' opinion on the significance of the topic feature.

In Figure 71 above we see the main themes of comments of students concerning the significance of the topic features. Students liked the real-world usage examples and the short descriptions regarding the topic themes. They thought they were easy to understand and make their learning/understanding of the topic better. Students especially liked the real-time nature concerning the significance of the topic. The student could get the significance of the topic and its application in the business world immediately while interacting with the chatbot. Concerning negative comments, some students preferred to read and get the significance of the topic from the book. Some students preferred longer texts in explaining the significance of topics. Some students thought that this feature may work for specific/focused topics but not for wider topics.

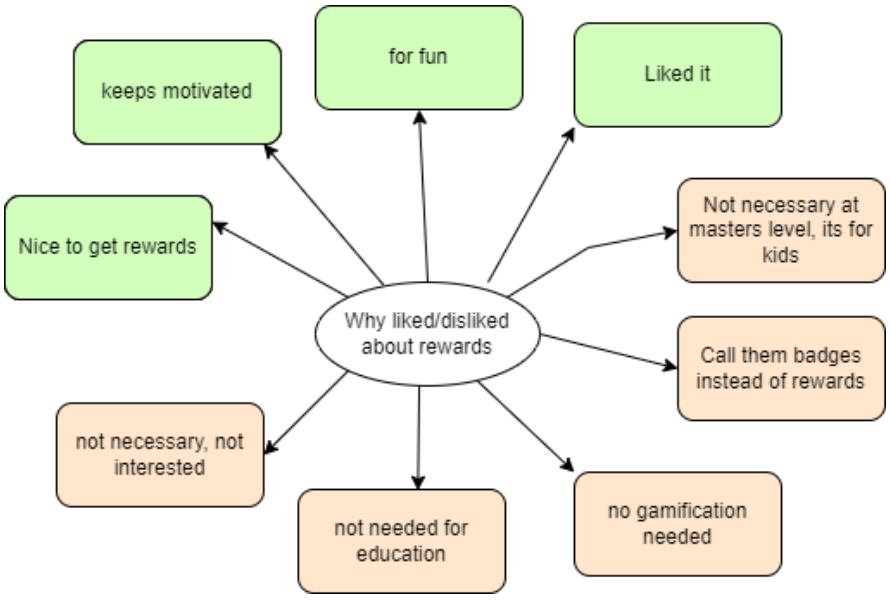



Figure 72 What students liked/disliked about the rewards section.

Above Figure 72 shows the different themes from the comments of students concerning the rewards section. Students thought it was nice to get rewards and it kept them motivated for learning. Students thought that it was fun to have them. While some students thought that it was not necessary to have rewards and they were not needed for education. Some thought that they were for kids and not for master's level. Some said that rewards should be named badges while some said that gamification was not needed.

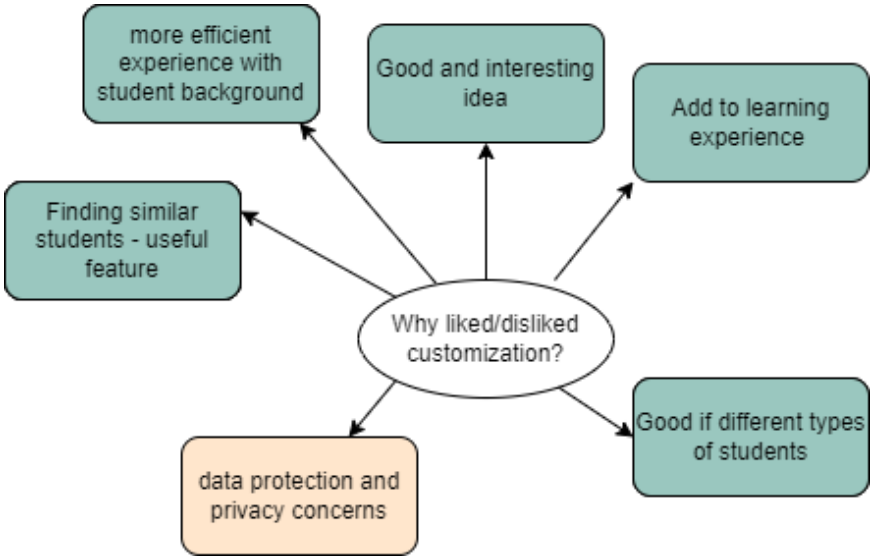



Figure 73: Students' comments concerning the customization section.

Students felt that showing the experiences of similar students was a useful feature and will add to their learning experiences. Customization will be particularly good if there is a variety of different types of students. Overall, the customization feature was thought of as a good and interesting idea to have an efficient experience with diverse student backgrounds. Refer the Figure 73 for the main themes concerning the customization feature.

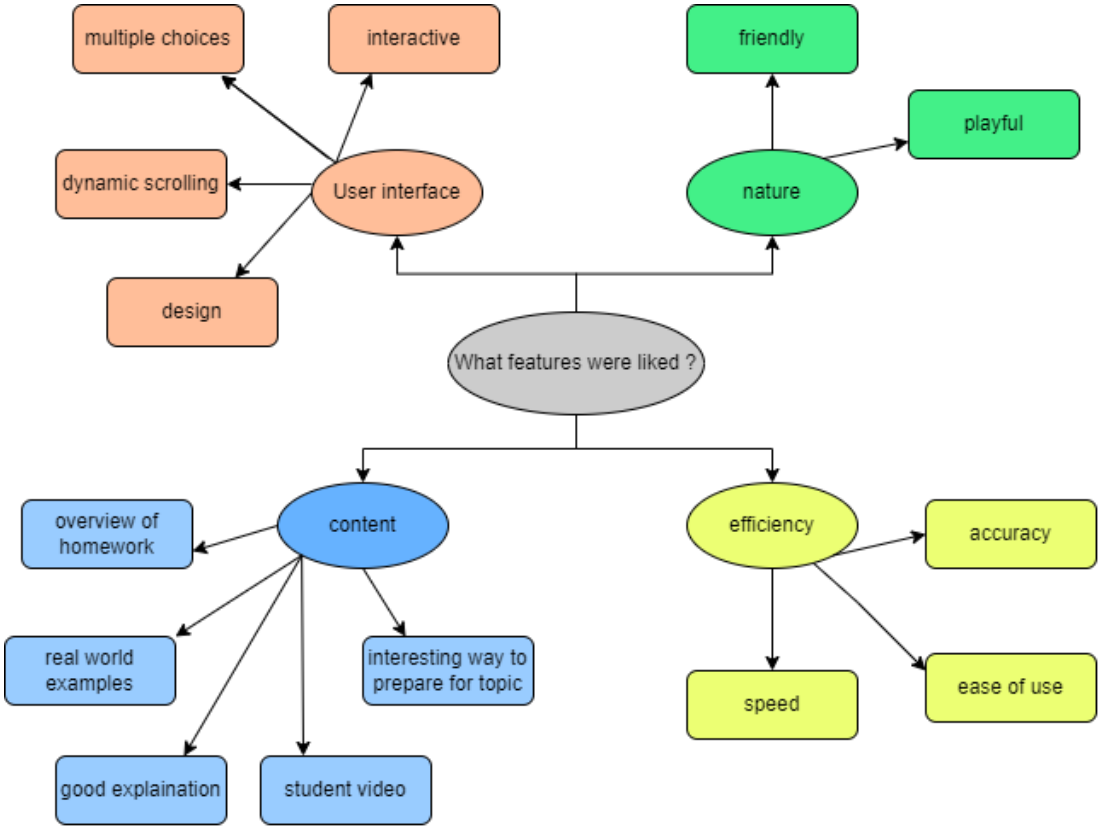



Figure 74: Features of chatbot liked by students.

The students were asked which features of the Flippy chatbot they liked. The comments were divided into different categories based on their type. The categories are displayed in Figure 74 above. Following is the explanation of the categories and comments: -

1. Students liked the user interface especially the design, and interactive nature with dynamic scrolling of the screen. Along with it, they liked the multiple-choice options (buttons) for user input.
2. Students liked the friendly and playful nature of the chatbot.
3. Concerning the content of the chatbot, the students liked the real-world examples of the topic and the overview of the homework. They thought the explanation of the topic was good and it was an interesting approach to prepare for the topic. Students liked the student video concerning peer experiences.
4. Students felt that the chatbot was efficient concerning the ease of use, speed of response, and accuracy.

## 6.4 Revised guidelines for the chatbot design.

In sections 5.1,5.2, we have seen the design, flow, and screens of the proposed chatbot to build intrinsic motivation and help students prepare for the flipped class in a particular flipped lesson of “Multidimensional modeling” in the Business Intelligence Module at the Master's Program of Business Information Systems at FHNW, Switzerland. The proposed chatbot Flippy was also evaluated for the flipped lesson in the actual FC setting. Students' inputs and suggestions found in the surveys and interviews are also considered while consolidating the key guidelines for designing the proposed chatbot. Table 15 below gives recommendations along with specific points to design the features of the chatbot for building intrinsic motivation among students concerning the flipped class preparatory context. It includes the category of the design feature along with the explanation of the category and the details of the chatbot features. The design guidelines can be used by chatbot designers to design the interactions and features of the chatbot meant for flipped class preparation. The focus is also on the integration of the factors of the significance of the learning topic and peer modeling. The inputs come both from the literature and the survey and interviews of the students from the flipped classroom.

| Category | Description | Recommended guidelines from literature and test results |
|---|---|---|
| Usage time and type of content | This category is responsible for how and when the chatbot will be used and the type of content delivered in the narrations. | ✓ Chatbot is to be used by students before the flipped class for preparation.<br>✓ It can deliver the topic content as well as links to the learning materials.<br>✓ It is to be kept lightweight with short content by default as it is meant to reduce information overload on students and deliver only key concepts.<br>✓ Due to the lack of time among students in the flipped class, it is recommended to use the chatbot for important topics. It is observed from surveys and interviews that all students might not like to use the chatbot due to their different learning preferences. Hence its usage should be kept optional.<br>✓ The topics and content need to be discussed with the tutor of the flipped class. |
| Conversation styles | The style defines how the chatbot and student will interact and type of the conversations between them and the different elements in the conversation. | 1. For a flipped class (FC) setting the recommended conversational style is visual-centric with the quick replies button as the menu options for the user inputs. The main aim to use a visual-centric conversational style is to reduce the information overload of students which is already high in an FC as seen from the literature review.<br>2. Content-centric style can also be used with informative and detailed answers mostly prepared in collaboration with the subject matter expert who is the tutor of the class.<br>3. Students suggested having free text-type questions that can be typed by them as input in the surveys and interviews. But this would unnecessarily complicate the preparation process in flipped classes and take away the time of the student. Time is an important part of the flipped class, and such style should be carefully considered while designing the chatbot. Such questions and answers can be used for basic questions related to the topic and assignment. |
| Delivery of the topic's important concepts and significance | This category is used as guidance to deliver the importance of the learning topic in a flipped class by the chatbot. In this part, the importance of the topic is given in a generic format and is implicit. | To explain the importance of the upcoming topic in the FC the following concepts can be considered in the design of the chatbot (M. Ryan and L. Deci, 2000; Hewlett, 2009; Pink, 2009; Kusurkar, Croiset and Ten Cate, 2011):-<br>✓ Explanation of the topic in brief with an example and a picture of the key concepts.<br>✓ The narration of the importance of the topic, and how the topic can help the student, the specific environment, and the different stakeholders to make processes/things efficient and solve problems.<br>✓ Examples of real-world usage of the concepts from the learning topic can be given to illustrate the key concepts.<br>✓ The skills and knowledge the student will gain and how they can solve real-world problems are also told with examples (mastery and skills). Peer modeling can also be used to explain the significance of the topic or its application in their professional contexts. |
| Delivery of the peer modeling concepts | This category is used as guidance to deliver peer modeling experiences in a flipped class by the chatbot. In this part, the importance of the topic is given in a specific format and is made explicit with specific examples from real-world contexts. | Peer modeling is effective when the peer model is similarly abled to the viewer student and more than one peer model example is given to students (Thelen *et al.*, 1979; Bandura, 1986; Schunk, 1987; Muir, 2018). Hence peer similarity functionality for the peer models can be incorporated into the chatbot while delivering the peer model experiences. Based on the educational and professional background of the viewer student similar peer models of similar professional, educational, and social backgrounds should be used (Murphey, 1996, 1998, 1999, 2003; Murphey and Arao, 2001; Muir, 2018). Peer models can be used to show the following in the flipped class with the help of a chatbot: -<br>✓ Use of both videos and narrations for peer modeling to demonstrate the variety and engage students (Bandura, 1997; Murphey and Arao, 2001; Belland, Kim and Hannafin, 2013).<br>✓ To explain what challenges peers faced during their flipped class tasks and assignments and preparation, and how they overcame them and were successful in solving the assignments in the flipped class. By doing this they could create a perception of optimally challenging tasks and inspire students to prepare and do the assignments well and help to build intrinsic motivation (Bandura, 1997; Murphey and Arao, 2001; Belland, Kim and Hannafin, 2013). |

| | | |
|---|---|---|
| | | ✓ To explain how the topic and assignment helped peers in their professional and/or academic life to solve problems and positively support bigger causes. This option is also preferred by some students in the student surveys in the chatbot evaluation.<br>✓ To tell how peers sometimes failed in their assignments and tasks and that it is OK to make mistakes but being persistent and trying leads to success in the flipped class (Murphey and Arao, 2001).<br>✓ To demonstrate strategies and methods for solving tasks and problems in the flipped class preparation (Bandura, 1997; Belland, Kim and Hannafin, 2013). |
| Customization | This category defines what data customization section can store to find similar peers and other data related to student preferences to give a personal learning experience for students. | ✓ To give an autonomy feeling to students in an FC the chatbot can provide customization settings for the personalization of the user experience (Yang and Aurisicchio, 2021).<br>✓ The customization can be concerning how the peer models are shown, and what background is compared for finding a similar peer. For example, educational background, social culture, or professional background must be considered while finding similar peers.<br>✓ The attributes for the student comparison for similarity depend on course to course and modules offered in the different educational programs.<br>✓ Options can be provided for students whether they would like to see students of similar backgrounds or different backgrounds concerning their backgrounds.<br>✓ Similar peers can be found based on the motivation for taking the module whether it's professional interest, general interest in the topic, or academic growth.<br>✓ Additional customization options for the look and feel for example: deciding the length of the text; having a static menu or navigation buttons in the chatbot can be kept delivering an optimum experience to the students. |
| Good to have features | The features of the chatbot that were most liked from the student interviews and surveys | ✓ Based on the student interactions with the Flippy chatbot, in section 6.3 it was found that students mostly liked the learning topic importance, peer modeling, and customization sections along with finding similar peers' functionality. While designing and developing the proposed chatbot initially the above-mentioned main features can be considered a higher priority. |
| Optional features | The features of the chatbot that were liked the least by the student interviews and surveys | ✓ The rewards section was liked by the students, but the number of these students was less than the students who liked other features. This feature can be kept as an optional feature in the chatbot design. Also, some students suggested renaming it as badges instead of rewards. |
| Delivery of the content | This category tells guidelines about how the content is delivered concerning the sequence, navigation, etc. | ✓ The main menu can have the options of the learning topic introduction, peer modeling, customization, rewards, assignment, and quit option. In each option, the branching starts, and the respective content is delivered. Every click of the option can first give a quick introduction describing the objective of that option. Tool tips can also be given on the option buttons to give a quick summary of the purpose of the button.<br>✓ For every concept, it is good to have a concise informative paragraph after which the chatbot should deliver a continue button to the next concept and deliver other options to quit or go to the main menu or assignment. This ensures that the information overload is less on students with less content and student has the autonomy to quit or change the navigation at any given point. Also, it is better to have the button option to explore the assignment at every stage so that the student explores the assignment whenever curious. |
| Improvement in the chatbot features | The features can be improved by students' suggestions and the | It is observed from the results of the chatbot test in the large class that it scored less in terms of the feeling of competency concerning the learning topic. This feeling would most likely get enhanced when students do the self-study on the topic. To further enhance the feeling of competency among students following changes can be considered: - |

| | | |
|---|---|---|
| | analysis of the test results data. | ✓ Peer modeling experiences can be delivered at the start of the chatbot interaction i.e., in the main menu. This will help students to access peer experience at the start of the chatbot interaction. This will grant students autonomy to explore the different aspects of the learning topic and specifically peer modeling.<br>✓ For peer modeling more videos can be used instead of text descriptions as students liked videos more as mentioned in the surveys. Also, it is observed in studies that students' self-beliefs about themselves are positively changed after watching peer modeling experiences via video format (Murphey and Arao, 2001).<br>✓ More examples of real-world topic use and peer model experiences can be given. as suggested by the students in the survey. Giving more peer model experiences strengthens the feeling of competency and confidence within students (Thelen *et al.*, 1979; Bandura, 1986; Schunk, 1987).<br>✓ Regarding peer models, similar as well as different background peer models can also be shown to students. Students can do this setting in the customization section. Those who select similar students will receive examples of similar students, and students who select different students will receive only those examples, if students select both, then both types of peer experiences will be delivered. Some students preferred diverse peer experiences as observed in interviews. Diverse peer models also help in increasing self-belief (Thelen *et al.*, 1979; Bandura, 1986; Schunk, 1987).<br>✓ We can also keep the options for setting the length of the responses as long text, or small text in the customization settings. Students who prefer short text for examples/content can set short text and will be delivered content in a small concise manner. While those who set the option as long text will receive long paragraphs. It was observed in student interviews that some students preferred to read more or longer texts while studying.<br>✓ A student suggested that the chatbot could send a warning to students about upcoming assignments and the time required to finish them. The chatbot could also send the students emails concerning upcoming assignments. This setting could be done in the customization section of the chatbot.<br>All these suggestions need to be checked for functional and technical feasibility before they are incorporated into the prototype in future work. Some of the important suggestions are incorporated in the improves prototype and the screen shots are provided in Appendixx 8.12. |

Table 15. Key chatbot design guidelines from theory and test results

# Chapter 7: Conclusion

The thesis focuses on the motivational challenges observed in flipped classrooms (FC) in higher university learning. It was observed in the Flipped Classroom literature and the FHNW case study that some students did not come prepared fully for the class. They skipped certain learning objects from the learning management system (Tangkittipon *et al.*, 2020). The reasons for not preparing for the flipped classroom were lack of time, a lot of preparation content, and low motivation levels as observed from the case study and literature (Khanova *et al.*, 2015; Bouwmeester *et al.*, 2019; Tangkittipon *et al.*, 2020). Intrinsic motivation is important for student engagement and good learning outcomes. The success of the flipped class depends on the motivation levels of the students (Johnson, 2013; Taylor, 2015). If the students do not prepare, then they will not understand the concepts taught in the class.

Intrinsic motivation is the inner drive that lets humans do tasks out of interest and fun and promotes creativity, gives better and lasting learning outcomes to students, and will give good outcomes in the flipped classroom preparation (Ryan and Stiller, 1991; M. Ryan and L. Deci, 2000; Simonson, 2017; Ryan and Deci, 2020). Peer Modeling (PM) theory suggests that students learn and get motivated by watching similar students perform the same task successfully (Schunk, 1987; Ohtani *et al.*, 2013). By watching other similar students perform, struggle, and then finally succeed with a task the self-efficacy and confidence of the students are increased concerning that task (Bandura, 1997; Zimmerman, 2000; McQuiggan, Mott and Lester, 2008). By seeing the challenges of their peers while performing tasks; the students feel connected and inspired. Peer modeling thus refers to narrating the learning experiences of students to other similar students to motivate and inspire students in their learning tasks (Bandura, 1997; Belland, Kim and Hannafin, 2013). Giving real-world usage examples of concepts is highly motivating and inspiring to students if the task is impacting them, society, or the company in a positive way or has a positive outcome on society (Hewlett, 2009; Pink, 2009). Peer modeling can be used to narrate experiences of how the learning topic helped them to do impactful work in organizations and societies. In organismic integration theory, it is observed that if humans identify and think that some activity is important for their growth then they integrate the activity into their daily life (Deci *et al.*, 1994; Ryan and Deci, 2000a). Then their behaviour becomes self-regulated. Over time this acceptance of the activity leads to interest in the activity and thereby promotes intrinsic motivation for that activity (Deci et al., 1994; R M Ryan and Deci, 2000). Kusurkar, Croiset and Ten Cate have suggested that teachers should explain the importance of learning topics (EILT) to students. If the students understand the importance of the topic, then they would study the topic autonomously (Kusurkar, Croiset and Ten Cate, 2011).

In the education field and especially in flipped classrooms there is a rise in the use of chatbot technology (Winquist and Carlson, 2014; Hew *et al.*, 2021). Chatbots have been shown to build intrinsic motivation among students using micro or small learning instructions for learning as observed in the literature review (Yin *et al.*, 2021). Chatbots have features that are shown to support the three psychological needs namely autonomy, relatedness, and competency (ARC), and hence show promise to build intrinsic motivation among students concerning learning topics in the FC as observed in the literature review in section 2.5.1.

The human-computer interaction designers mostly focus few known intrinsic motivation-building factors based on the Self Determination Theory (De Vreede, Raghavan and De Vreede, 2021; Yang and Aurisicchio, 2021). But there is hardly any focus on peer modeling (PM) and explanation of the importance of learning topics (EILT) factors to promote intrinsic motivation through chatbots in the FC. PM is known to promote competency by creating a perception of an optimal challenge (Bandura, 1997; Belland, Kim and Hannafin, 2013) while EILT is known to promote self-regulation and autonomy, and both show promise for intrinsic motivation (Deci *et al.*, 1994; Ryan and Deci, 2000a). The combination of PM and EILT factors is not used in a chatbot for intrinsic motivation and therefore it is a gap found in the literature review. To address these issues the focus of the thesis is on the following research question.

*"How can the peer modeling (PM) experiences and the importance of learning topics (EILT) be used to intrinsically motivate students to prepare for the flipped class setup using a chatbot?"*

The thesis follows a design science methodology that focuses on the development of an artifact that solves real-world problems observed in the context of business processes and organizations (March and Smith, 1995; Hevner *et al.*, 2004; Iivari, 2005; Hevner, 2007; Peffers *et al.*, 2007; Baskerville, 2008; Carcary, 2011). In the thesis work, low motivation is observed in flipped classrooms both in the literature and the case study of FHNW. The research objective is to find ways to deliver the intrinsic motivation-building factors namely PM and EILT through chatbots to enhance the intrinsic motivation of students in flipped classrooms. In the development phase, the proof of concept of a chatbot named Flippy is developed in the context of the FHNW case study for the flipped lesson" multi-dimensional modeling (MDM)" from the "Business Intelligence" module from the master's program "Business Information Systems". To support factors EILT and PM chatbot Flippy explains the

4. Importance of the learning topics by introducing the topic with examples using text and images.
5. Real-world usage of the topic with examples and how it helps the stakeholders in their daily work. It also tells students what skills they will gain after they do this topic and how it will help them in their work experience.

To support peer modeling the chatbot provides a simulation of similar students' experiences via video and text narrations.

## 7.1 High-level evaluation takeaways

In the autumn semester of 2022, the Flippy chatbot was given to interact with the Business Intelligence class students (43) a week before the *Multidimensional modeling* topic started. A survey was conducted to analyze the ACR needs of the students. The chatbot scored good points considering the factors of autonomy and relatedness with the students. Autonomy is related to the flexibility and choices given by Flippy to explore the MDM topic. Relatedness is related to the easy-going and friendly nature of the chatbot. *It is known that feelings about ARC promote intrinsic motivation among students* (Ryan and Deci, 2000a; Trenshaw *et al.*, 2016). It is seen that the interactions with Flippy enhanced the interest among students regarding MDM topic exploration. Many students also enjoyed the interactions with Flippy. Interest in an activity or task is an indicator of intrinsic motivation among students (Harackiewicz, 1979; Ryan, 1982; Deci and Ryan, 1985; M. Ryan and L. Deci, 2000). Experiencing enjoyment/fun during tasks also indicates intrinsic motivation (M. Ryan and L. Deci, 2000). Thus, it can be concluded that interactions with the Flippy chatbot led to the enhancement of intrinsic motivation among a subset of students in the flipped classroom.

The students also felt competent to prepare for the MDM topic and with their skills after chatbot interaction. This competency is related to the confidence among students concerning their current skills and abilities after knowing about peer experiences. But competency-related ratings were less as compared to other factors. The feeling of competency would further increase when students prepare well for the topic by reading the materials and doing the assignment. The Flippy chatbot did not promote negative feelings among most of the students during the chatbot interaction. Many students felt that the MDM topic was important to study and that they would put effort to prepare for it after chatbot interactions. This thought process is better from the perspective of intrinsic motivation as students would thus autonomously choose to study the MDM topic rather than study it under pressure or external influence. Following were some important results from qualitative student survey questions and interviews: -

1. Most of the students preferred to use Flippy again for other topics. Students liked the friendly and interactive nature of the chatbot and the content variety like text, video, and images that it provides. Students felt that the chatbot was helpful in their preparation as it provided them with a quick summary of the main points of the topic. On the other hand, some students liked to read long content from pdf and books and preferred human interaction over chatbots for learning.
2. Most students liked the customization feature the most and thought finding similar students was a useful feature, especially when the students are of different backgrounds.

They thought it was a good and interesting idea to customize the user experience and it added to their learning experience. On the other hand, a few students had some concerns regarding the data protection and privacy issues that come with the storage of student preference data.

3. For many students, the significance of the topic feature of the chatbot was helpful to get a better understanding of the topic. They especially liked the real-world examples and short descriptions or summaries of the important themes in the topic. Some students liked to have more real-world examples concerning the learning topic embedded in the chatbot.
4. After the significance of the topic, most students liked the peer model experiences. Students found peer experiences motivational, interesting, and positive. Students liked the video peer model experiences more than the text ones. Few students found peer experiences did not add any value to learning.
5. The least liked feature of the chatbot was the rewards. Some students thought rewards to be motivational and liked them for the fun they provided. Some students preferred to have rewards renamed as badges. While some thought that rewards were not needed for education.
6. The findings from the initial survey and interview results from Spring 2022 semester suggest that students who were from a different background other than the Business intelligence topic preferred to use the proposed chatbot for their preparation. The short concepts and examples given by the chatbot particularly appealed to these students. On the other hand, it was observed that those who are highly motivated and have background knowledge about the topic would prefer long texts to read from the preparation material rather than go through the chatbot. But this was observed in a small set of students and needs to be further investigated by the chatbot researchers.

Following are some suggestions for improving the features of the chatbot to further enhance the ACR factors.

1. To further enhance competency with peer modeling, this feature can be kept at the main menu level so that students get more freedom to see the peer experiences at the start of the chatbot interaction and get interested without any preconceived notion about the learning topic. Some students did not reach the peer models section as they were confused about the flow, and some did not find them easily. Thus, keeping the peer models on the menu main can solve this problem.
2. Also, more video examples of peer modeling can be delivered as students liked the video examples more than text narrations in evaluation surveys in both semesters. Moreover, more real-world examples can be added in chatbot narrations based on the learning topic as some students preferred more examples of the learning topic.
3. The reward section can be renamed as *Claim a Badge* as some students suggested.

4. For students who prefer longer or shorter texts, the customization section can offer students the option to set the text length (short, medium, long). The chatbot can thus provide more or fewer details to the students based on their preferences. This information derived from evaluation results will help chatbot researchers and designers to carry out further research in PM and EILT in the chatbot for educational purposes.
5. The chatbot could be kept as an optional activity so that students don't feel pressured to use it. Also, it is observed that the novelty effect of the chatbot wears off after a few uses (Winquist and Carlson, 2014; Fryer *et al.*, 2017). To maintain the interest of the students the chatbot can be used only for important topics that are rich in concepts.

## 7.2 Research contribution

The thesis contributes to the field of chatbot design for enhancing intrinsic motivation specifically flipped classroom techniques. The existing literature research only supports the chatbot designing features that look at the well-known factors from the Self Determination Theory (SDT). The thesis combines the concepts of PM and EILT along with SDT factors that are incorporated into design guidelines for chatbots to enhance the intrinsic motivation of students in flipped classrooms. It specializes in the enhancement of the SDT theory factors with the PM and EILT factors. The thesis will thus help the FC tutors to design intrinsically motivating student chatbots. Please refer to

*Figure 75* below for the research contribution overview.

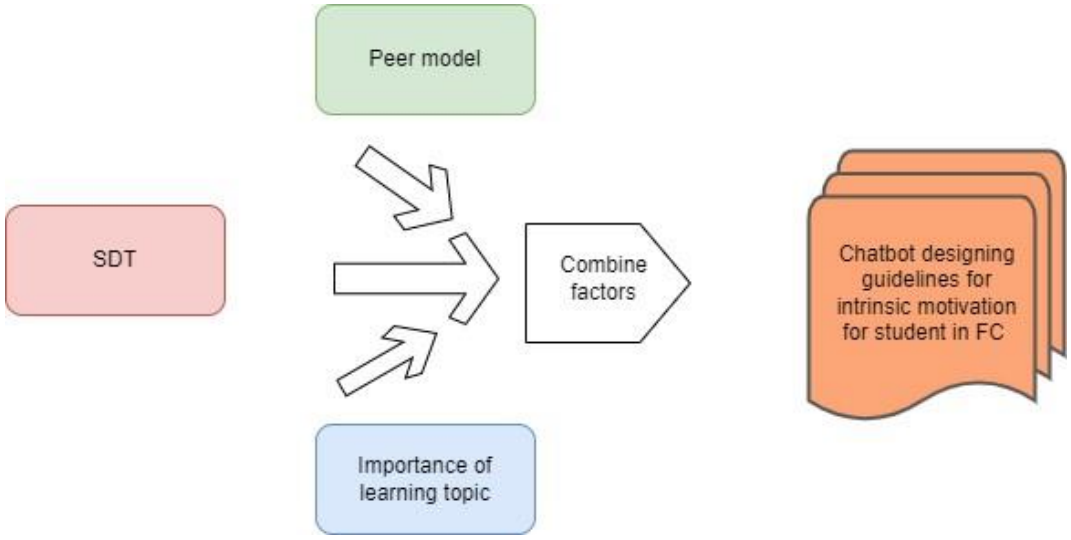



Figure 75: Research Contribution

## 7.3 Limitations and further research

The thesis research outcomes create more avenues for further research in the unique area of use of chatbots that incorporates PM and EILT factors to build intrinsic motivation for preparation in FC. Following are the limitation along with key areas in which further research should be conducted: -

1. More research needs to be conducted to find whether a chatbot is likely to be used by students who are less motivated and of different backgrounds and knowledge levels. Also, it needs to be checked whether students who are already highly motivated would be interested to use the chatbot.
2. The proposed chatbot tool in the thesis is evaluated in a large class setting. The students gave some recommendations to improve the features of the chatbot. The chatbot needs to be further enhanced by the student recommendations concerning PM and EILT. More research design cycle iterations will ensure the effectiveness of the chatbot concerning intrinsic motivation. For example: delivering more examples of video peer modeling at the start of chatbot interactions, providing more examples in general, and providing custom options to set the chatbot text lengths.
3. Research needs to be conducted for a larger and more diverse student class. Moreover, the case-based reasoning technique used in a similar recommender system is not evaluated for its efficiency. More research needs to be done in this area concerning what attributes students prefer for similarity, which method is more effective to find similar peers etc.

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# Chapter 8: Appendices

This chapter contains the important data from student surveys, interviews, and online resources used in the thesis research work. This data is referenced from different chapters and sections within the thesis.

## 8.1 Business intelligence class survey

1. I asked the student whether they prepared before the upcoming BI Reporting and Dashboarding class and nearly 93.8% said that did prepare for the class. Nearly 6.3% of students answered that they did not prepare before that specific class. Refer to Figure 76 Question for preparation for BI reporting and dashboarding class.

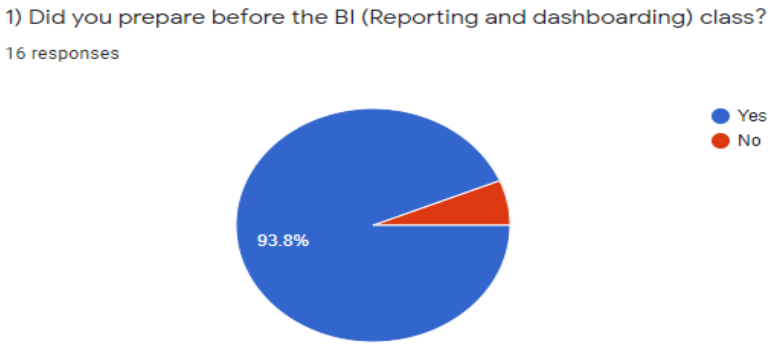



Figure 76 Question for preparation for BI reporting and dashboarding class

2. In this question students were asked about the preparation activities that the student did before the class: 56.3% of students said that they went through the preparation materials. While 43.8 % of students said that they went partially through the materials. While 6.3 % of students said that they did not download and did not go through the preparation materials. Thus, we can say from the figures that almost 49% of students did not go through the preparation materials thoroughly. Refer to Figure 77: Question-related to preparatory activities before class.

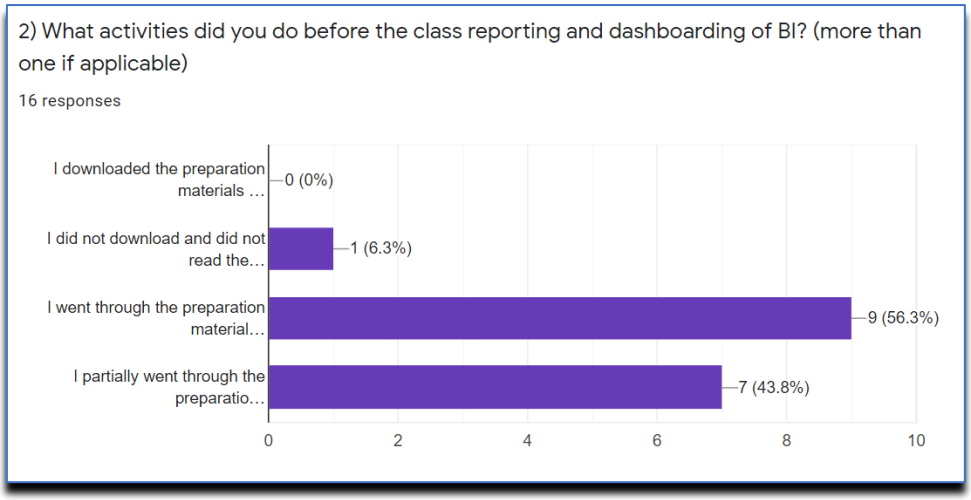



Figure 77: Question-related to preparatory activities before class

3. To understand how the students did the preparation, they were asked in which sequence they prepared for the classroom. Fifty percent of students read the material before the quiz while 43.8% read some parts of the material before taking the quiz. While 6.3% of students said they referred to materials in parts while doing the quiz. Refer to the Figure 78

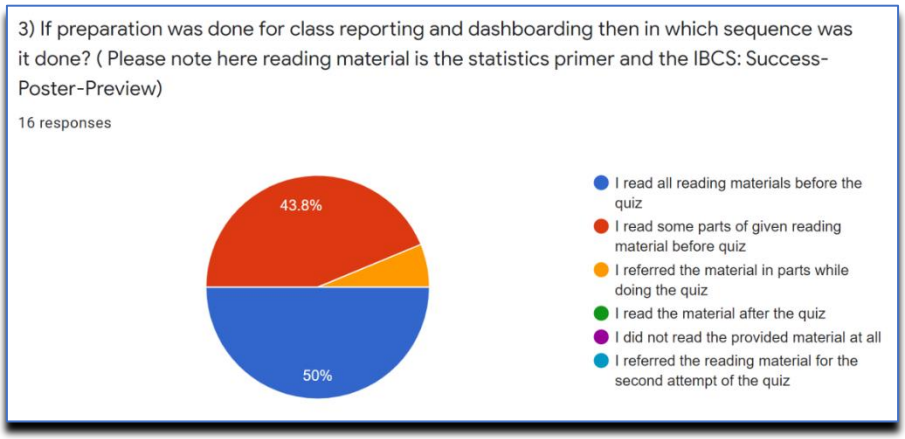



Figure 78 Question related to the sequence of preparation.

4. Next, the students were asked why they selected the sequence in above question 3 for preparation. This question was posed to understand the motivation of students for the selected sequence of preparation. Most of the students replied that they preferred to read the material before the class as they can have background knowledge of the topic and are thus well prepared for taking the quiz and the flipped class. Following were the answers of the students.
    - I have some background knowledge
    - Goog motivated
    - I don't like making a quiz without knowing the background. That's why I read first and then do the quiz.

- I just read the primer which was very informative and then I started with the quiz. I didn't had time to watch additional information.
- I found easy to understand the material
- This topic is completely new to me, that is why i startet with the provided material
- to be prepared from class and benefit from class.
- I read the primer after the class was held. For the sequence, I knew that the paper was optional but wise to read before attending the quiz

5. The students were asked about the main reasons for not going through the preparation materials. Predefined options were given for selection. Nearly 70% of students selected the option I had too little time for. While 30% of students selected the option, I already knew the concepts from previous programs (Bachelor's). While 20% of students selected the option, I lacked the motivation to go through the materials. Another 20% of students selected the option I found the material not sufficient to solve problems. While another 20% of students selected the other option. Ten percent of students selected the option "It was difficult for me to understand the material". Refer to Figure 79 Reasons for not going through preparation .

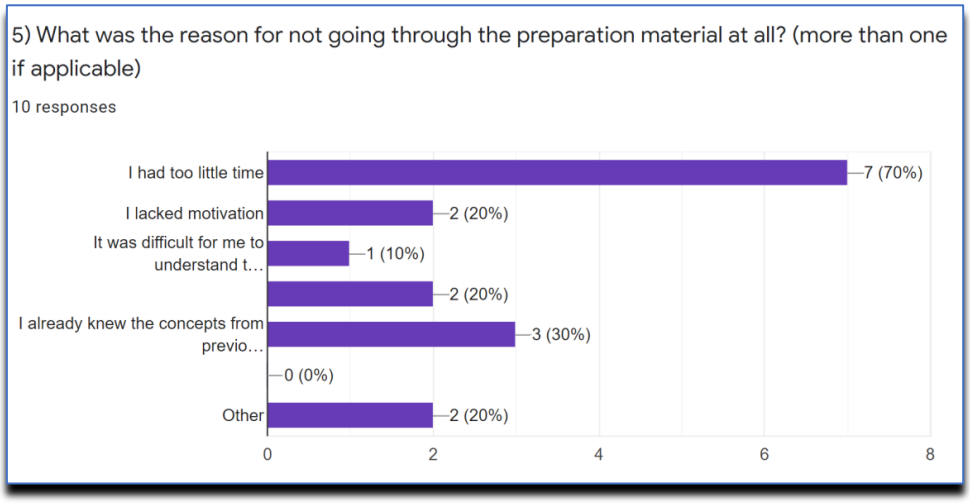



Figure 79 Reasons for not going through preparation materials.

6. Students were asked to specify the other reasons for not going through the material. Most of the material was related to the preparation content. Refer to Figure 80 Response to other options.

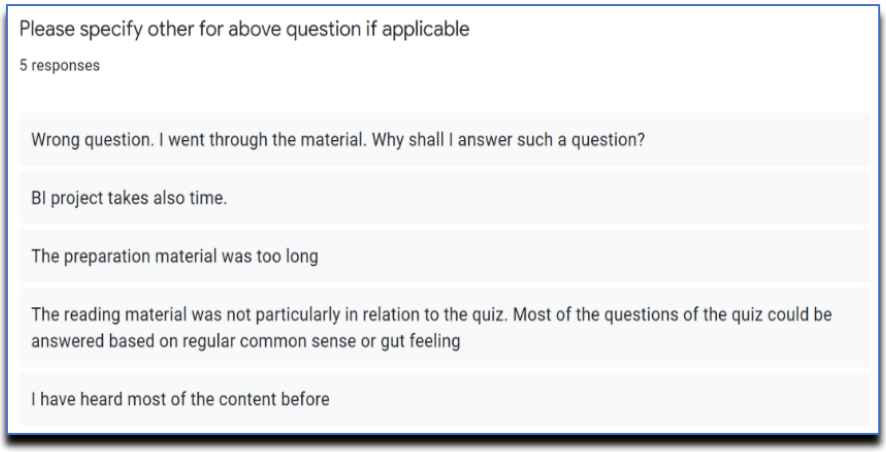



Figure 80 Response to other options

7. To understand in which setting the preparation and quiz were undertaken I asked students where they prepared for flipped class. Nearly 68.8% percent of students prepared at home. While 12.5 students took in office during the break, 6.3 % mentioned "During travel/transit time (train, etc.)", 6.3% during college hours, and another 6.3% during train, home, and office breaks. Refer to Figure 81 Where was the preparation done?

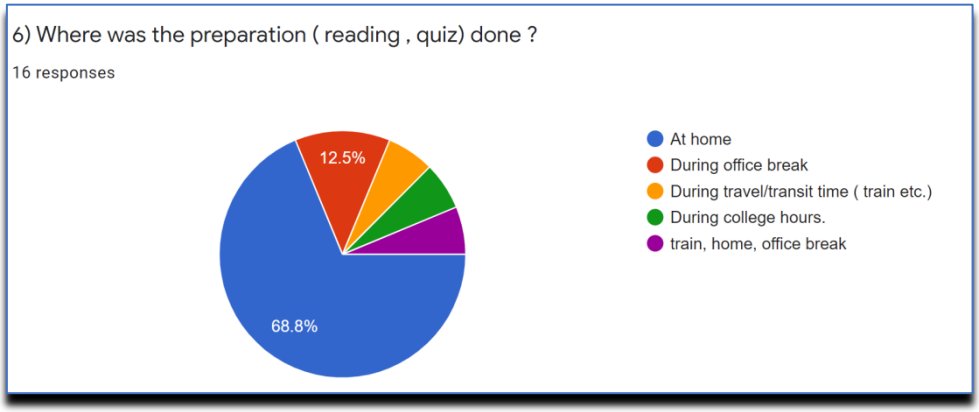



Figure 81 Where was the preparation done?

8. The students were asked how they found the preparation material. Nearly 68.8% of students said that "I found the preparation material somewhere between my knowledge level of the subject". Twenty-five percent of students selected the option "I found the preparation material easy to understand". Nearly 6.3% of students selected the option "I found the material difficult to understand and beyond my knowledge level of the subject". Refer to Figure 83 How did you find the material?

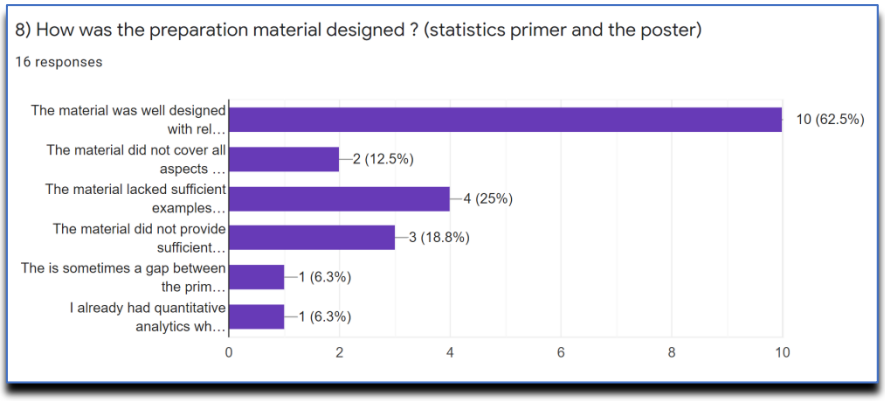



Figure 82 How was the preparation material designed?

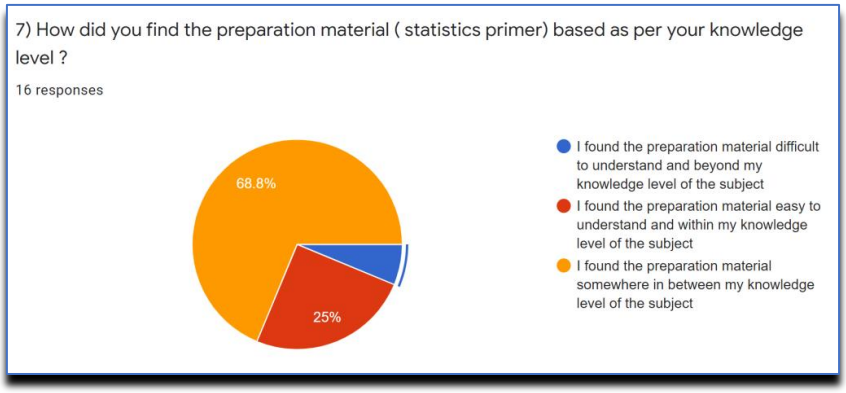



Figure 83 How did you find the material?

9. The next question asked to the students was “How was the preparation material designed?”. Nearly 62.5% of students selected the option “The material was well designed with relevant highlights of the topic”. Nearly 25% of students selected the option “The material lacked sufficient examples to help solve the quiz”. About 18.8% of students selected the option “The material did not provide sufficient steps to solve the questions in the quiz”. Nearly 12.5% of students selected the option “The material did not cover all aspects of the topic”. About 6.3% of students selected the option “The material did not cover all aspects of the topic, The is sometimes a gap between the primer and the quiz.”. Another 6.3% of students selected the option “The material was well designed with relevant highlights of the topic, I already had quantitative analytics which helped me.” The last 2 answers were added via the other option in the question. Refer to Figure 82 How was the preparation material designed?
10. In the next question, students were asked if they wanted to add any more relevant points related to the preparation materials. Many students said that the preparation material was quite long and needed more examples and some enhancements in the presentation. Refer to Figure 84 Relevant points about preparation materials.

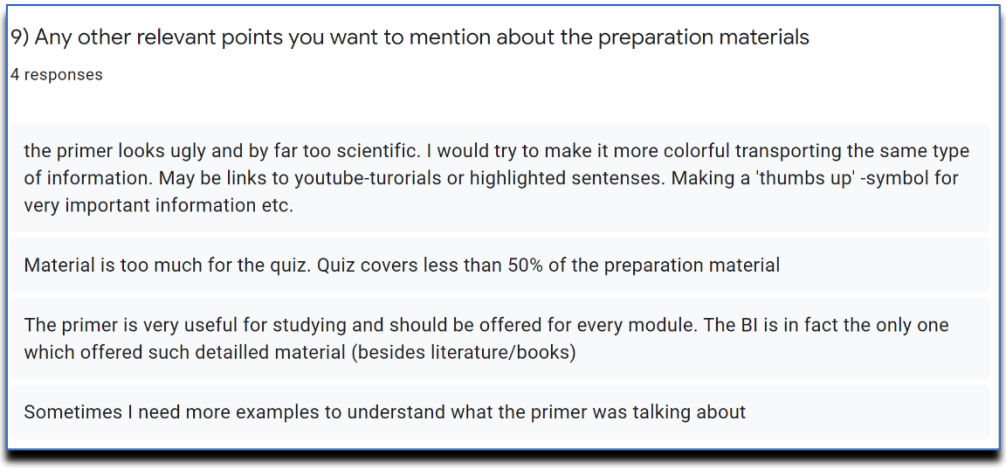



Figure 84 Relevant points about preparation materials

11. In the next question, students were asked a question about "*How were the questions solved in the quiz*?" Nearly 93.8% of students selected the option "*Some questions were solved by trial-and-error method*". About 87.5% of students selected the option "*Some questions were solved by analysis by me*". While 75% of students selected the option "*Some questions were solved by referring to the provided study materials*". Nearly 62.5% of students selected the option "Some questions were solved by applying past knowledge, and experience". About 6.3% of students selected the option "*Some questions were solved with the help of a knowledgeable peer*." And 25% of students selected the option "*Some questions were solved by referring to other content from the internet*". Refer to Figure 85 How were questions solved in the quiz?

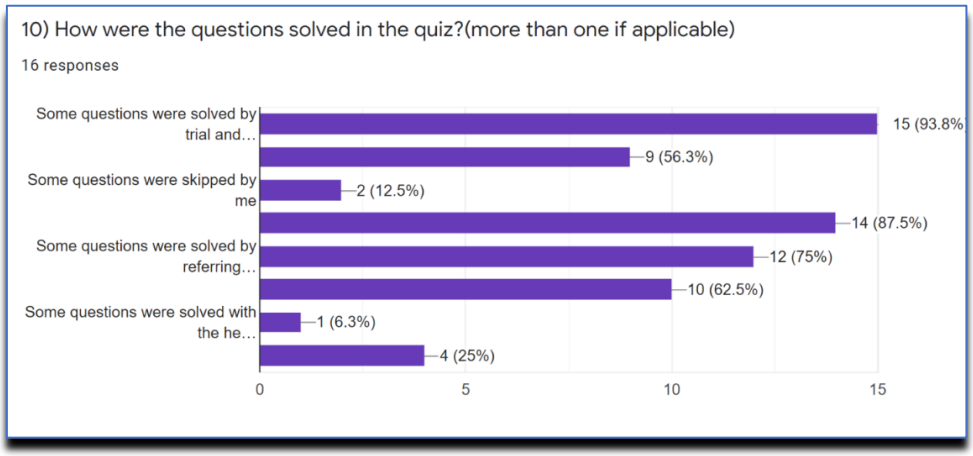



Figure 85 How were questions solved in the quiz?

12. Next, to understand why the students took the quiz in the sequence observed in Moodle log analysis the following question was asked: "*What was the reason for not solving all questions or using guesswork or trial and error methods? (More than one if applicable)*". Nearly 71.4% of students selected the option "*I found some questions were complex*". About 28.6% of students selected the option "*I did not know the exact steps to solve some*

*questions*." About 21.4% selected the option "Other". Nearly 7.1% of students selected the option "*I did not go through the preparation material*" another 7.1% of students selected the option "*I was not motivated to solve all questions*" and another 7.1% of students selected the option "*I had no time*". Refer to Figure 86 What was the reason for not solving all questions?

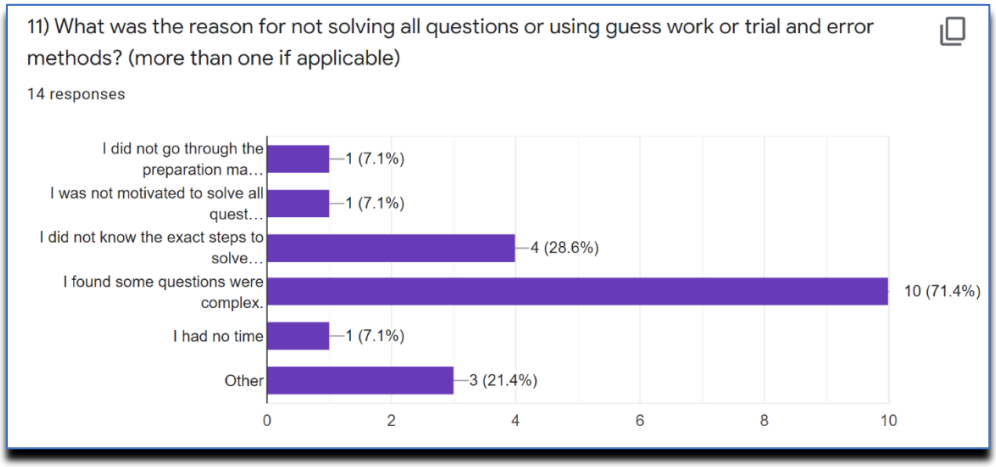



Figure 86 What was the reason for not solving all questions?

13. Following was the student's response to the option Other. Some students highlighted the drawback of the use of Moodle such as formatting issues, and yes and no options for Moodle functions. Some students stated that the quiz answers were not precise while some said that the quiz questions were time-consuming. Refer to Figure 87 Other reasons for not solving all .

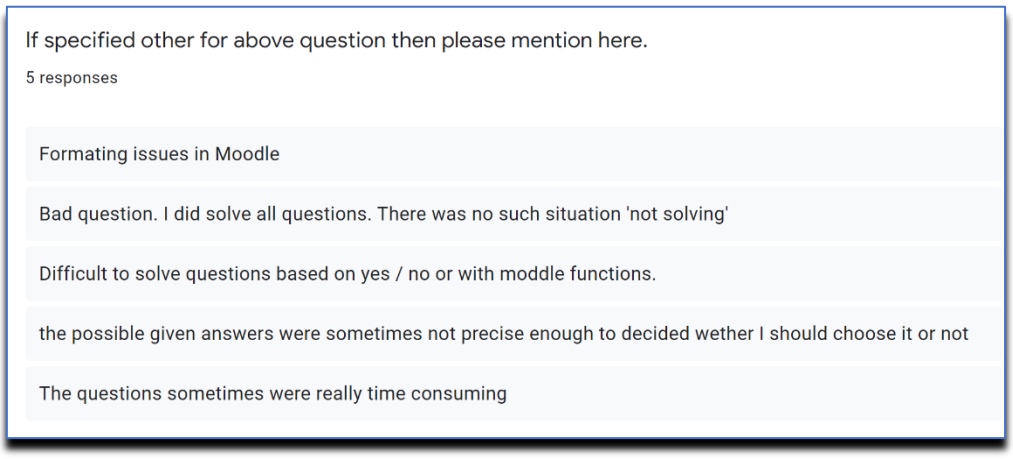



Figure 87 Other reasons for not solving all questions.

14. It was observed during the analysis that some students had entirely skipped the quiz. To understand the reason behind it, the students were asked the following question "*What was the reason for not taking the quiz at all*?". Nearly 66.6% of students selected the option "*I had no time*". While 22.2% of students selected the option "*I felt that the quiz*

*was tough*" 22.2 % of students selected the option *Other*. Almost 11.1% of students selected the option "*I was not motivated*". Refer to Figure 88 What was the reason for not taking the quiz?

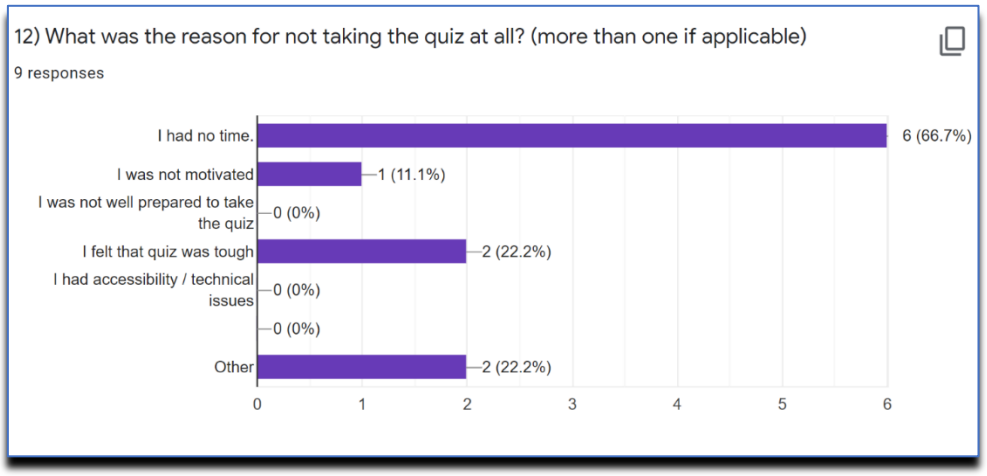



Figure 88 What was the reason for not taking the quiz?

15. In the next question, students were asked "What would have helped you to be more engaged in class?". Nearly 46.7% of students selected the option relevant hints/steps to solve a question. About 40% of students selected the Other option. Nearly 26.7% of students selected the option "Discussing problems with knowledgeable instructor or tutor". Nearly 20% of students selected the option "Discussing problems with students". About 6.7% of students selected the option "Less difficult questions" another 6.7% of students selected the option "No grading for a quiz" and another 6.7% of students selected the option "Designing quiz more interestingly." No students selected the option "More difficult questions". Refer to Figure 89 What would have helped you to be more engaged in the quiz?

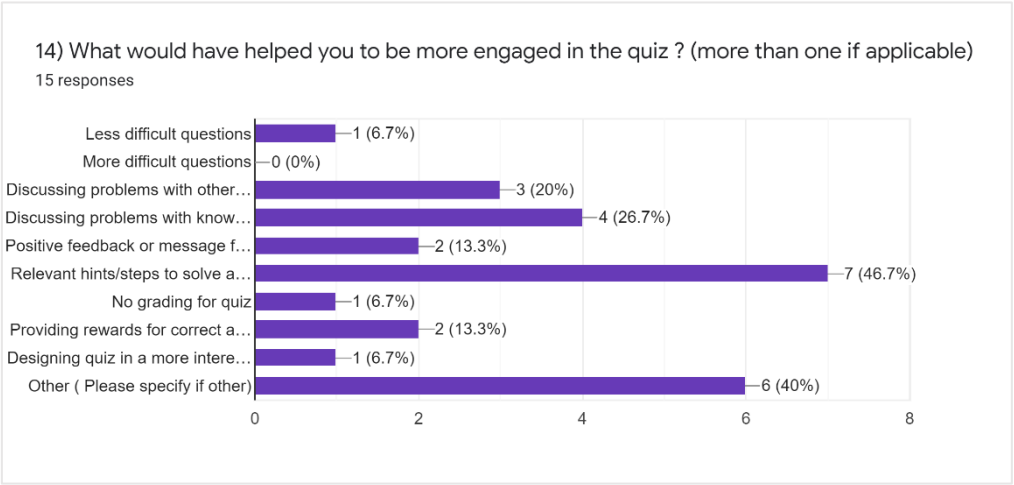



Figure 89 What would have helped you to be more engaged in the quiz?

16. Students were asked to specify the reasons for other options. Most of the responses were related to the long questions asked in the quiz, clarity about what to read from preparation materials, and the confusing Moodle structure. Some students also thought that the preparation material was too long. Refer to Figure 90.

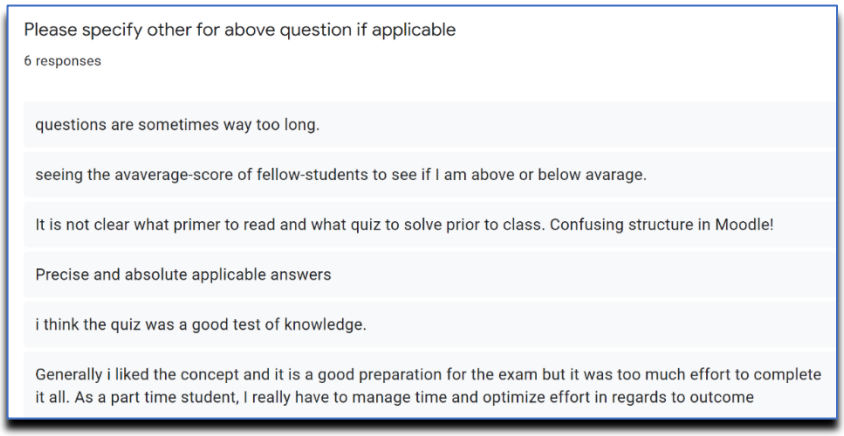



Figure 90 Other reasons to help engage in a quiz.

17. Next, the students were asked, "*What would help to make classroom preparation a much more positive experience for you?"* About 40% of students selected the option "*Granting freedom/flexibility to students for preparation (E.g., selecting the preparation topics depending on how they want to deepen their knowledge, selecting quiz levels/questions of their choice)*". Twenty-six % of students selected the option "*Make preparation activities more collaborative/interactive in nature."* Nearly 40% of students selected the option "*Provide real-time help in solving problems and skill building*" and another 26.7% of students selected the option "Other". Refer to Figure 91 What would help to make classroom preparation more positive? When asked about the details for their option "Other" the following responses were given by them: -

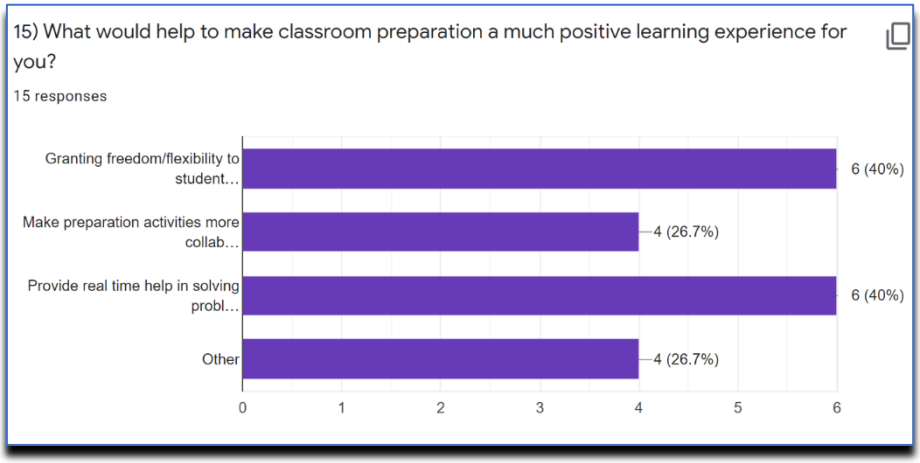



Figure 91 What would help to make classroom preparation more positive?

For the other category in question, 15 above students gave the following answers below. Some students liked the preparation materials. Some students mentioned having different ways of preparation like assignments, and model charts which will help them to save time. Refer to Figure 92 Other reasons to make class preparation .

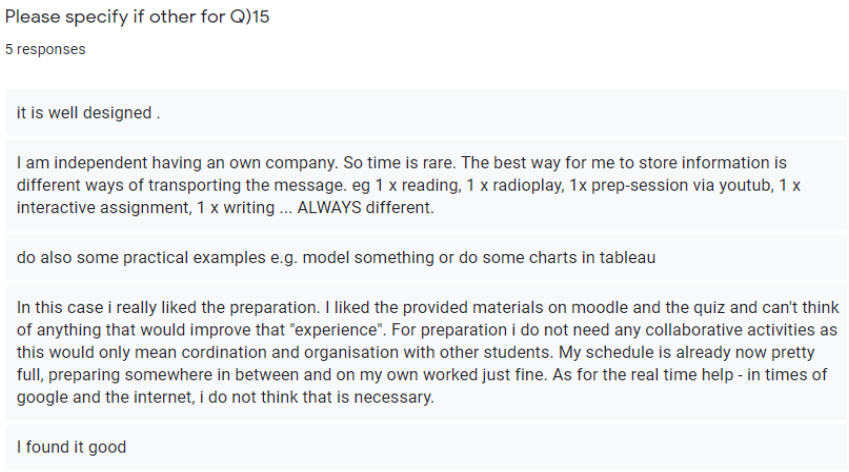



Figure 92 Other reasons to make class preparation positive.

18. The students were asked how they found the preparation material. Nearly 68.8% of students said that “I found the preparation material somewhere between my knowledge level of the subject”. Twenty-five percent of students selected the option “I found the preparation material easy to understand”. Nearly 6.3% of students selected the option “I found the material difficult to understand and beyond my knowledge level of the subject”. Refer to Figure 93 How did you find the preparation material?

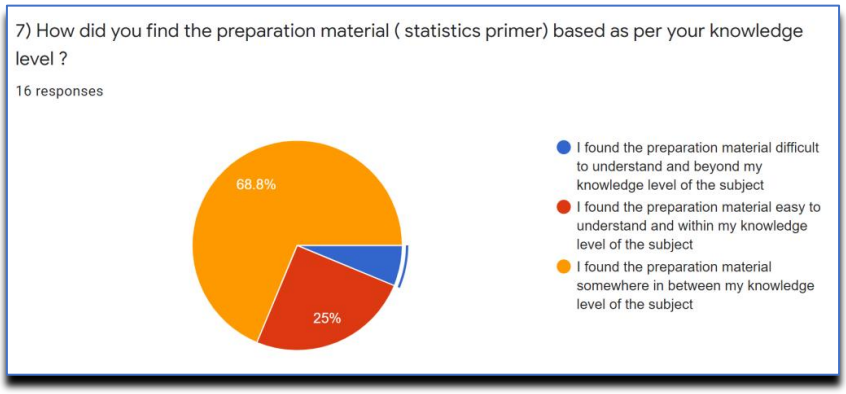



Figure 93 How did you find the preparation material?

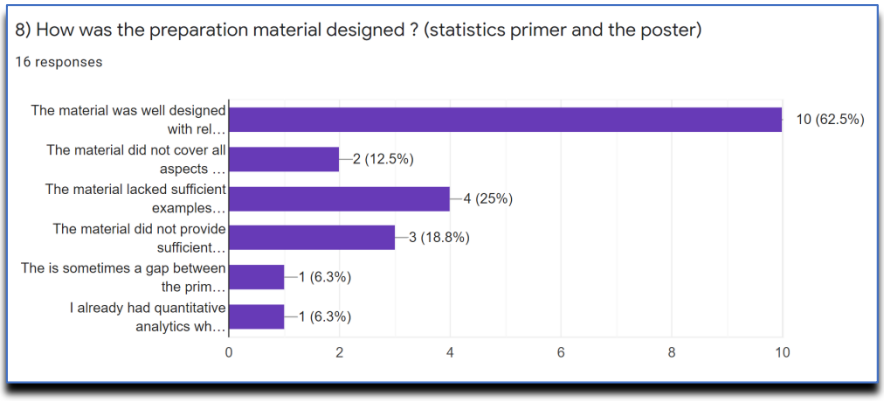



Figure 94 How was the preparation material designed?

19. The next question asked to the students was "*How was the preparation material designed*?". Nearly 62.5% of students selected the option "*The material was well designed with relevant highlights of the topic*". Nearly 25% of students selected the option "*The material lacked sufficient examples to help solve the quiz*". About 18.8% of students selected the option "*The material did not provide sufficient steps to solve the questions in the quiz*". Nearly 12.5% of students selected the option "*The material did not cover all aspects of the topic*". About 6.3% of students selected the option "The material did not cover all aspects of the topic, The is sometimes a gap between the primer and the quiz.". Another 6.3% of students selected the option "The material was well designed with relevant highlights of the topic, I already had quantitative analytics which helped me." The last 2 answers were added via the other option in the question. Refer to Figure 94 How was the preparation material designed?
20. In the next question, students were asked if they wanted to add any more relevant points related to the preparation materials. Many students said that the preparation material was quite long and needed more examples and some enhancements in the presentation. Refer to Figure 95 Other points about preparation materials.

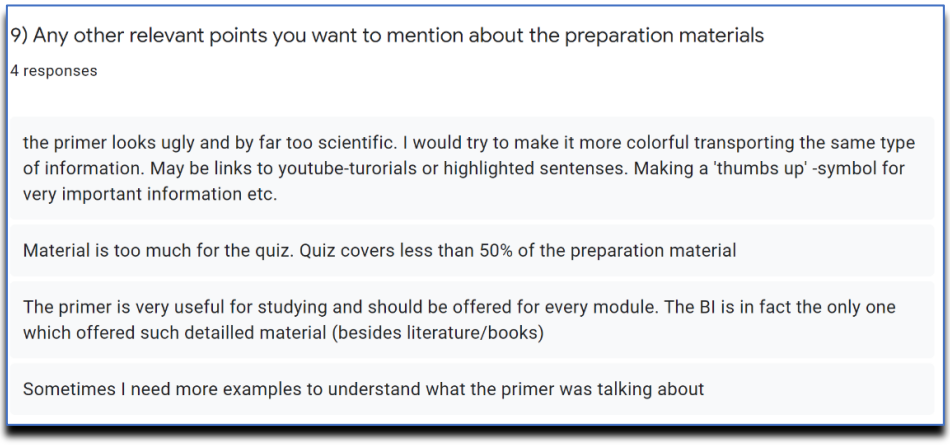



Figure 95 Other points about preparation materials

21. In the next question, students were asked a question about "How were the questions solved in the quiz?" Nearly 93.8% of students selected the option "Some questions were solved by trial-and-error method". About 87.5% of students selected the option "Some questions were solved by analysis by me". While 75% of students selected the option "Some questions were solved by referring to the provided study materials". Nearly 62.5% of students selected the option "Some questions were solved by applying past knowledge, and experience". About 6.3% of students selected the option "Some questions were solved with the help of a knowledgeable peer." And 25% of students selected the option "Some questions were solved by referring to other content from the internet". Refer to Figure 96 How were the questions solved in the quiz?

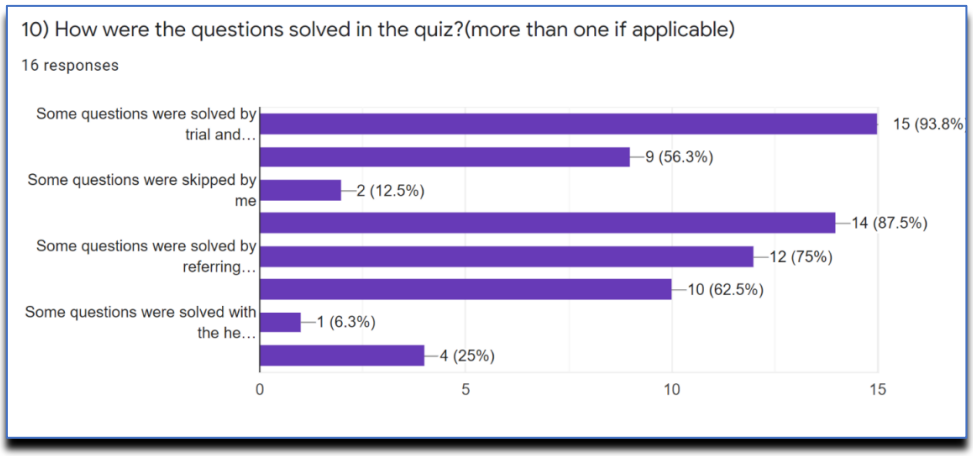



Figure 96 How were the questions solved in the quiz?

22. Next, to understand why the students took the quiz in the particular fashion observed in Moodle log analysis the following question was asked: "*What was the reason for not solving all questions or using guesswork or trial and error methods? (More than one if applicable)*". Nearly 71.4% of students selected the option "*I found some questions were complex*". About 28.6% of students selected the option "*I did not know the exact steps to solve some questions*." About 21.4% selected the option "Other". Nearly 7.1% of students selected the option "*I did not go through the preparation material*" another 7.1% of students selected the option "*I was not motivated to solve all questions*" and another 7.1% of students selected the option "*I had no time*". Refer to Figure 97 Reasons for not solving all questions.

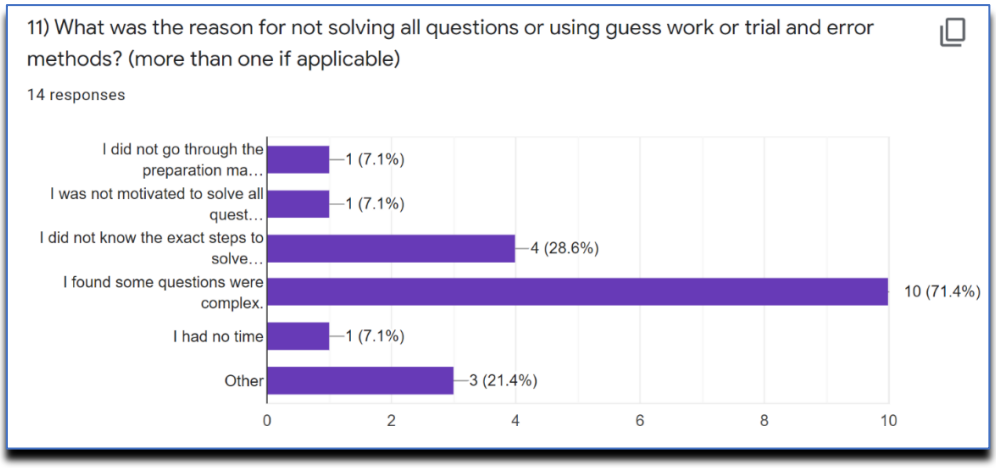



Figure 97 Reasons for not solving all questions.

23. Following was the student's response to the option Other. Some students highlighted the drawback of the use of Moodle such as formatting issues, and yes and no options for Moodle functions. Some students stated that the quiz answers were not precise while some said that the quiz questions were time-consuming. Refer to Figure 98 Other reasons for not solving all .

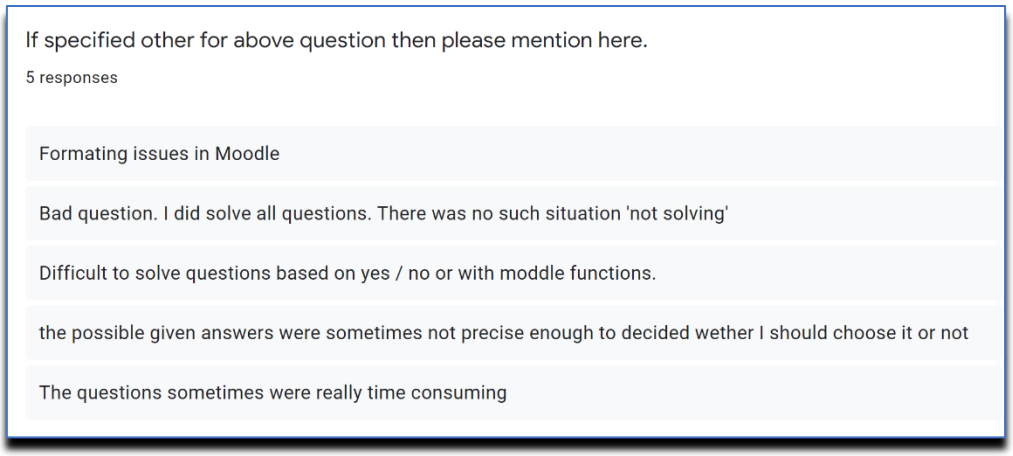



Figure 98 Other reasons for not solving all questions.

24. It was observed during the analysis that some students had entirely skipped the quiz. To understand the reason behind it, the students were asked the following question "*What was the reason for not taking the quiz at all*?". Nearly 66.6% of students selected the option "*I had no time*". While 22.2% of students selected the option "*I felt that the quiz was tough*" 22.2 % of students selected the option *Other*. Almost 11.1% of students selected the option "*I was not motivated*". Refer to Figure 99 What was the reason for not taking the quiz at all?

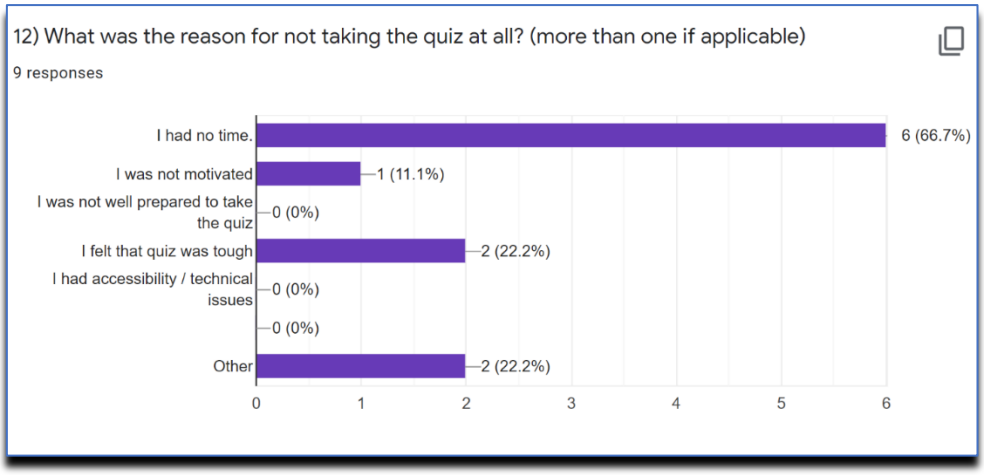



Figure 99 What was the reason for not taking the quiz at all?

25. In the next question, students were asked "What would have helped you to be more engaged in class?". Nearly 46.7% of students selected the option relevant hints/steps to solve a question. About 40% of students selected the Other option. Nearly 26.7% of students selected the option "Discussing problems with knowledgeable instructor or tutor". Nearly 20% of students selected the option "Discussing problems with students". About 6.7% of students selected the option "Less difficult questions" another 6.7% of students selected the option "No grading for a quiz" and another 6.7% of students selected the option "Designing quiz in a more interesting way." No students selected the option "More difficult questions". Refer to Figure 100 What would have helped you to be more engaged in the quiz?

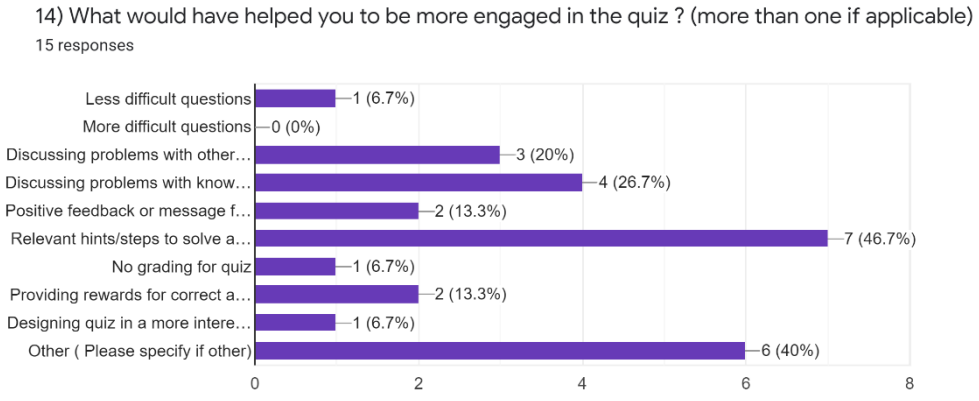



Figure 100 What would have helped you to be more engaged in the quiz?

26. Students were asked to specify the reasons for other options. Most of the responses were related to the long questions asked in the quiz, clarity about what to read from preparation materials, and the confusing Moodle structure. Some students also thought that the preparation material was too long. Refer to Figure 101.

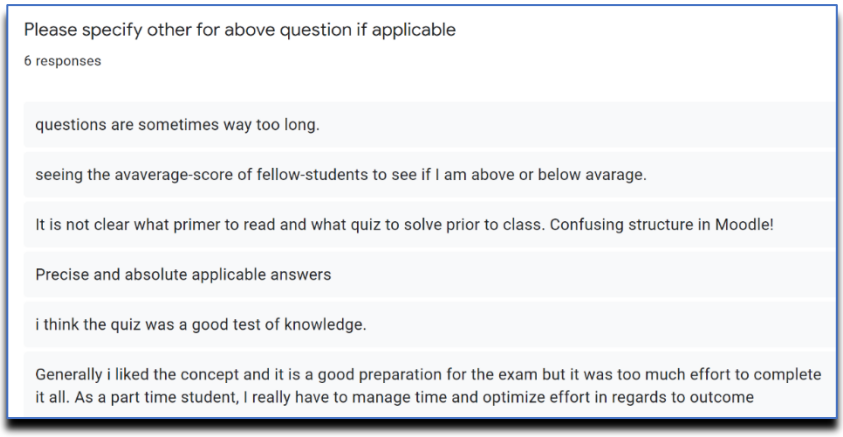



Figure 101 Response for other reasons

27. Next, the students were asked, "*What would help to make classroom preparation a much more positive experience for you?"* About 40% of students selected the option "*Granting freedom/flexibility to students for preparation (E.g., selecting the preparation topics depending on how they want to deepen their knowledge, selecting quiz levels/questions of their choice)*". Twenty-six % of students selected the option "*Make preparation activities more collaborative/interactive in nature."* Nearly 40% of students selected the option "*Provide real-time help in solving problems and skill building*" and another 26.7% of students selected the option "Other". Refer to Figure 102 What helps to make classroom preparation a positive experience?

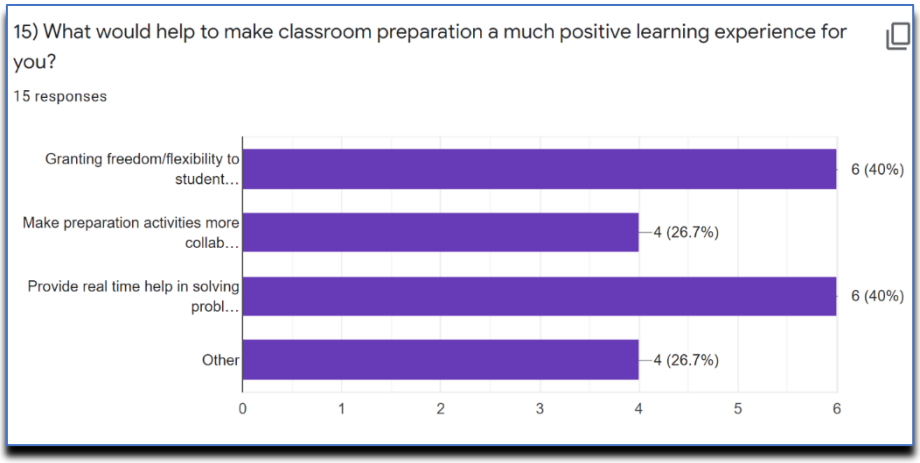



Figure 102 What helps to make classroom preparation a positive experience?

For the other category in question, 15 above students gave the following answers below. Some students liked the preparation materials. Some students mentioned having different ways of preparation like assignments, and model charts which will help them to save time. Refer to Figure 103 Other reasons for positive classroom experiences.

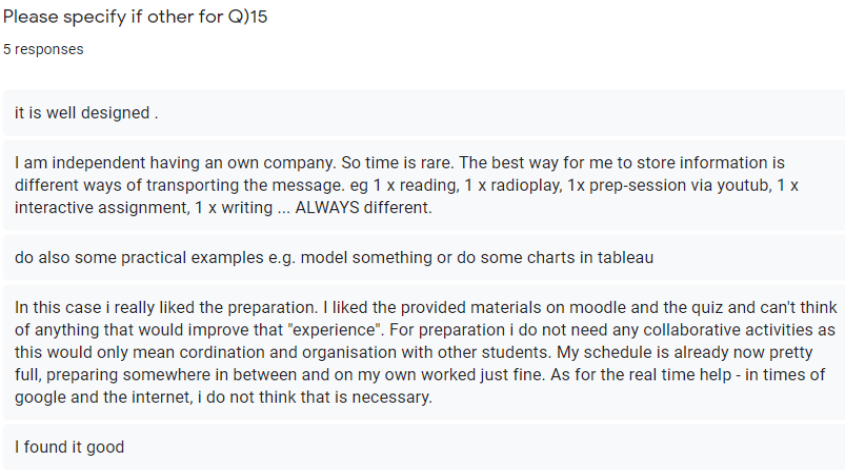



Figure 103 Other reasons for positive classroom experiences

## 8.2 Peer modeling and tutor interview questions

The following questions were asked of students in interviews to collect their experiences concerning peer modeling for the Multidimensional modeling topic: -

1. How did you prepare for the topic of multi-dimensional modeling?
2. What was your motivation for preparation for this particular topic? (out of interest, professional or academic interest)?
3. How was the experience of preparation (reading primer, taking the quiz) in particular? Did you face any challenges?
4. How did the assignments help you with understanding the concepts in the class, doing the final assignment, and in the professional tasks?
5. How did skills gain from this topic help you in the academic world i.e. in the final exam and project assignment? What problem did you solve here? An example would be great. What was the positive outcome? (Good grades, a good understanding of concepts, etc.). How were the results used in the company process?
6. How did the skills from this topic help you in your professional life? Did you solve any problems in your company by using multi-dimensional modeling? What was the positive outcome of this problem-solving for you? For example (got a new project, new client, promotion, etc.)

Following are some of the peer model narrations made from the student interviews. Such narrations will be delivered via the peer modeling feature in the chatbot. Prior consent was taken from the student to make such narrations. Student names are kept anonymous.

1. HHH worked as a working student (entry-level) in project and portfolio management in an insurance agency and has a bachelor's degree in business information technology. He worked part-time and did the master's program at FHNW.

His motivation was to enhance his knowledge in the Business Intelligence topic as he already studied it in his bachelor's. HHH knew that the multidimensional modeling (MDM) topic is an important one for the exam and he made a summary of this topic for preparation. He had some issues in understanding the basic concepts of facts dimensions and true to the grain that is not explained in the primer. He had to go through some online articles to understand these concepts. He thought it was good to prepare for the quiz, especially for the final exam. HHH thought that the prior preparation for the MDM topic helped him to understand and visualize the problems adequately. He thought that the preparation for the topic is important as students could ask their doubts in class. The class preparation for the multidimensional topic helped him and his project group to apply their knowledge in the final project with a bank. The bank had some issues with data labelling. Their project group identified the problem and made new visualizations to show the problem areas and how they could fix the labelling issue. They applied the concepts mostly from the MDM topic.

2. LLL had a bachelor's degree in business administration and studied full-time at the FHNW, Business School. LLL did not have a technical background or prior knowledge of the Business Intelligence module. But after learning the Business Intelligence (BI) module her interest increased and she wanted to work in a technical field. She felt that after learning this module she had gained skills that are highly demanded in the industry. LLL prepared the multi-dimensional modeling topic by reading the primer and assignment for the class. She found it difficult to apply the concepts in the assignments due to her non-technical background. So, she had to refer to the examples from the quiz and the primer from time to time to revise her basic concepts for the final assignment. LLL thought that the quizzes and the class exercise for MDM helped her to solve the modeling problems in the final exams. She felt the questions in the final exam were already solved in the prior classes. For her final project, she did data classification for invoices for a company. The MDM concepts helped her to analyze very complex and large data sets. She thought that the BI and MDM skills gained during the final assignment helped her to gain holistic knowledge about the whole process of mining intelligent information from the raw data.

3. MMM worked as Business Analyst for an Information Technology (IT) team for developers. She worked in the domain of the financial industry. She worked full-time and studied at FHNW Business School. She had a bachelor's degree in business administration. She thought that the Business Intelligence module was most interesting for her as she wanted to connect with the real business world. She took this module for professional growth as she dealt with technical people in her profession. Usually, she prepares for the classes and takes the quiz, and was well prepared with summary notes. She liked the primer material for the MDM topic. MMM felt that MDM modeling was a tough topic. She took a lot of effort to understand the topic. She felt that the real-world assignment helped her to apply her concepts and to make data models for the company. The concepts learned in the MDM class helped her in understanding real business requests like how many visitors came to the website, and how many users clicked. etc. It helped MMM to visualize the data models and gather business requirements from the business as well as the IT team.

The following questions were asked of the tutor to define the content of the Multidimensional modeling topic significance, professional examples, and skills gained in the chatbot.

1. Are there any interesting facts or examples as to how MDM is used in companies or any success story of use in a company?
2. An example use of MDM in a domain-specific process?

3. As per you, is anything specific for students like to hear about multidimensional modeling? From your previous experiences?
4. Any other thing or concept you would like to add to the MDM description while the chatbot explains the importance to the student? Any cool concept or example?
5. What skills are gained by students from the MDM topic?

## 8.3 Survey related to student background information.

This survey is a part of research conducted to find suitable student peer role models for helping and motivating students in their class assignments. I collected student background information to identify factors/features that could serve as similarity measures for recommending peer role models to students during classroom assignments in Business Intelligence Class. The data collected will only be for finding similar peers in the solution part of the software artifact of the thesis. The questions in the survey map to the attributes of the near-peer models given in the section Peer model attributes. More details on their selection and explanation are given in the suggestions/solutions section. Please refer to Table 16 below to understand the different questions asked in the survey.

Table 16 Student background survey questions

| Question | Peer attribute | Type and possible values |
|---|---|---|
| Please specify your bachelor's degree program. For example, Computer Science, Electrical engineering, etc. | Education background | Open-Ended. The student should enter the name of the degree program (bachelor). |
| Please specify the name of the University from where you got your bachelor's degree and its location (city/country). | Education background | Open-Ended. The student should enter the name of the University and location. |
| Please specify work experience in years | Education background | Integer |
| Please specify the professional level. | Education background | The user can select from entry-level, intermediate,mid-level/managerial, executive, other |
| Please specify your job function/department and role. For example, 1) working in the Information technology department as a software developer 2) legal department as legal advisor etc. If not relevant, then please specify as not applicable. | Education background | Open-ended |
| Please specify the job industry (business domain). For example, Software industry, Healthcare, Pharma, Banking, etc. If not relevant, then please specify as not applicable. | Education background | Open-ended |
| What is your job workload? | Education background | Possible values can be part-time, full time, or not applicable |
| Did you have a break or sabbatical in your professional career? | Education background | Possible values, Yes or No |
| If yes, please specify the reason for the career break. For e.g. relocation, studies, family reasons, etc. Otherwise, specify as Not applicable | Education background | Open-ended text |
| Nationality | Demographic | Open-ended text |
| Gender | Demographic | Possible values, male, female |
| Please state your family status. Select multiple values if applicable | Demographic | Possible values: Single, married, with kids, living with parents, living with a partner, other. |

| | | |
|---|---|---|
| Understanding statistical summaries of variable distributions, such as mean, median, standard deviation, and correlation coefficient - and knowing when to best apply them for summarizing data. | Competency/knowledge level | These values are given to capture the competency level of the student in that particular subject on a scale from 0..5. Zero means a beginner and 5 means an expert in that topic. |
| Knowing the various visual data representations (bar chart, line chart, scatter plot, etc.) and how to best apply them to answer analytical questions. | Competency/knowledge level | These values are given to capture the competency level of the student in that particular subject on a scale from 0..5. Zero means a beginner and 5 means an expert in that topic. |
| Recognizing which (numerical or categorical) variables are needed to answer given analytical questions. | Competency/knowledge level | These values are given to capture the competency level of the student in that particular subject on a scale from 0..5. Zero means a beginner and 5 means an expert in that topic. |
| Understanding of Online-analytical processing (OLAP / pivot tables) and OLAP operations | Competency/knowledge level | These values are given to capture the competency level of the student in that particular subject on a scale from 0..5. Zero means a beginner and 5 means an expert in that topic. |
| Multi-dimensional modeling in Business intelligence: being able to recognize facts, dimensions, and fact measures in analytical questions. | Competency/knowledge level | These values are given to capture the competency level of the student in that particular subject on a scale from 0..5. Zero means a beginner and 5 means an expert in that topic. |
| Multi-dimensional modeling in Business intelligence: Understanding of data modeling languages (such as ME/R and mUml) and their representation in relational databases (star schema). | Competency/knowledge level | These values are given to capture the competency level of the student in that particular subject on a scale from 0..5. Zero means a beginner and 5 means an expert in that topic. |
| From where did you get the above knowledge? Select all applicable options | Background, experiences | Possible values can be work experience, courses at University, Training, not applicable, or others. |

## 8.4 Student survey results: chatbot group

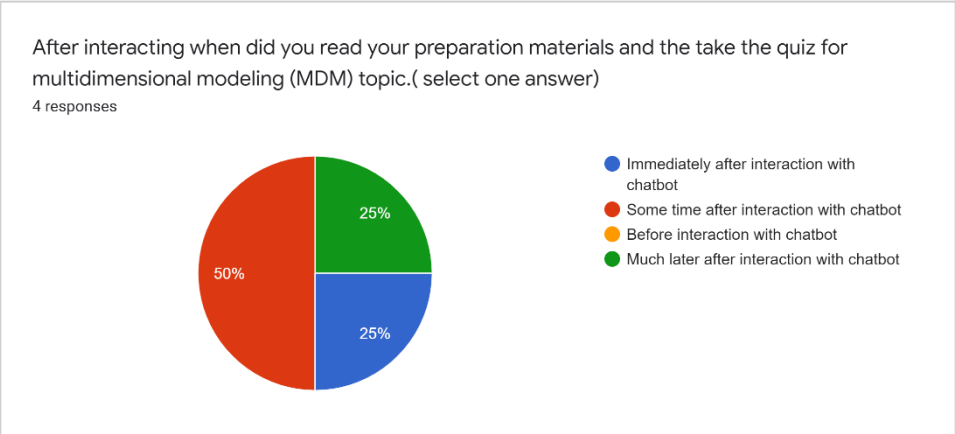



Figure 104 Chatbot group survey statement 1

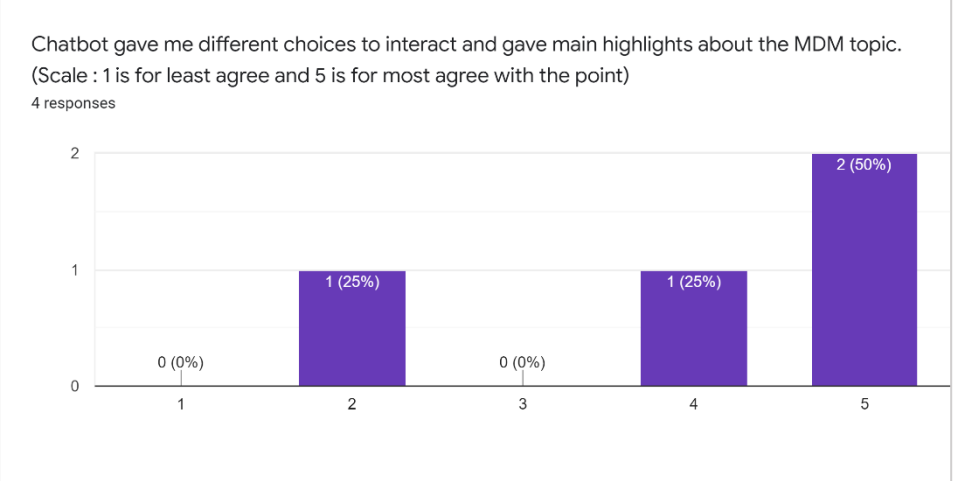



Figure 105 Chatbot group survey statement 2

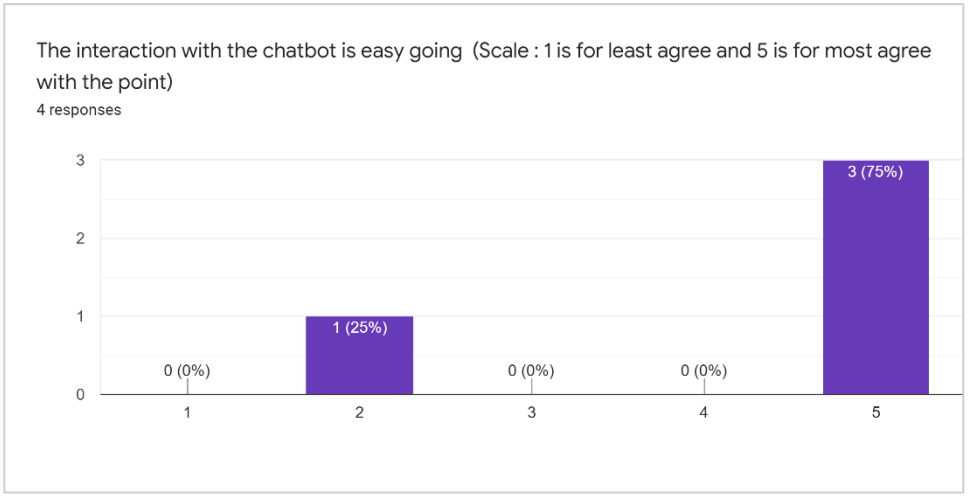



Figure 106 Chatbot group survey statement 3

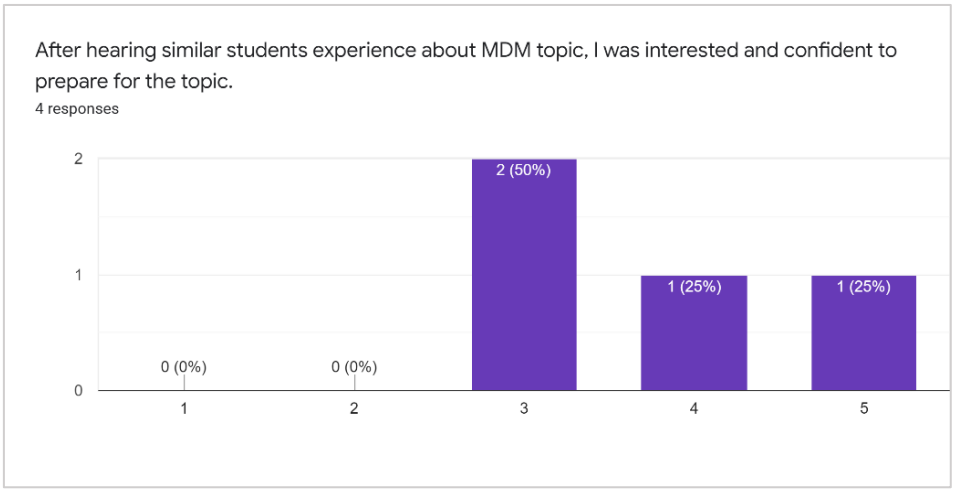
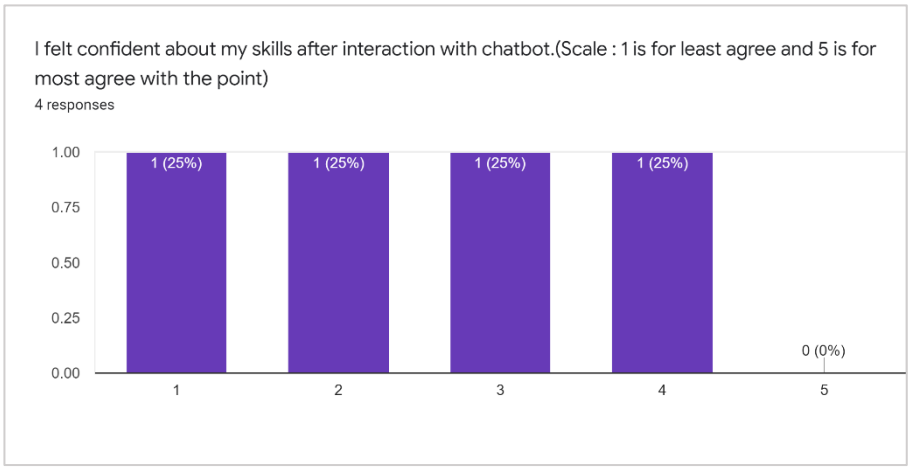



Figure 107 Chatbot group survey statement 4

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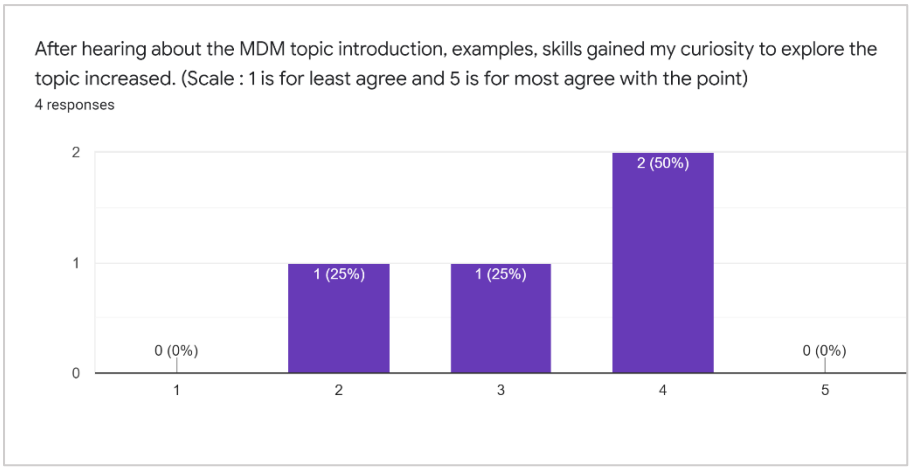
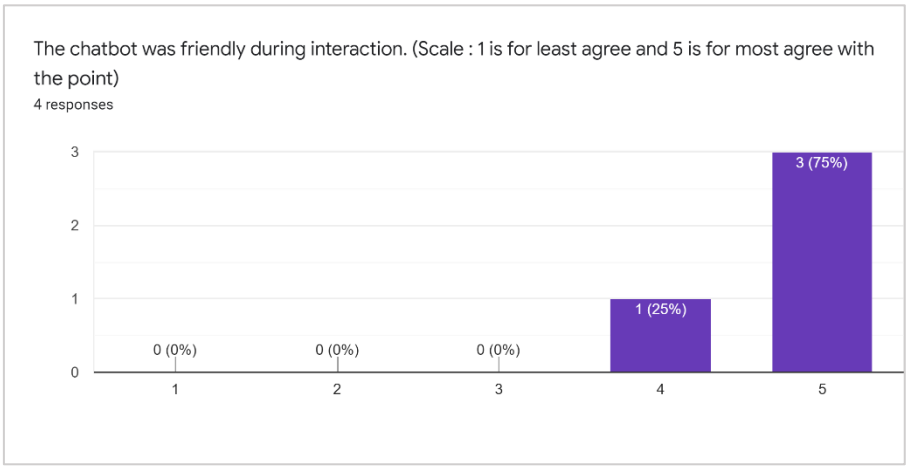



Figure 109 Chatbot group survey statement 6

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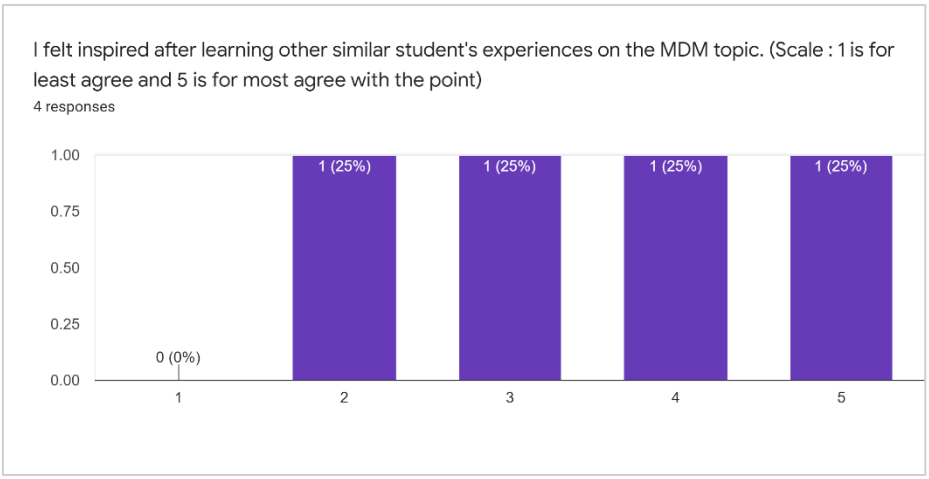



Figure 111 Chatbot group survey statement 8

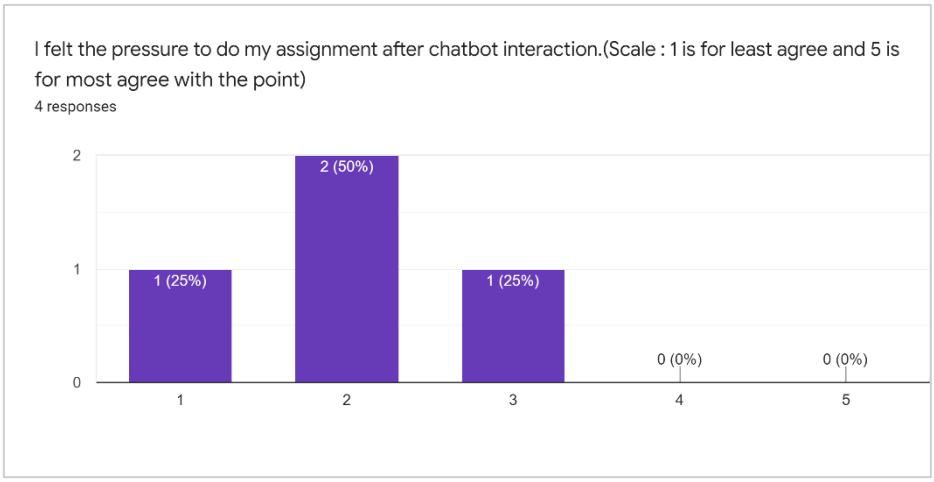



Figure 112 Chatbot group survey statement 9

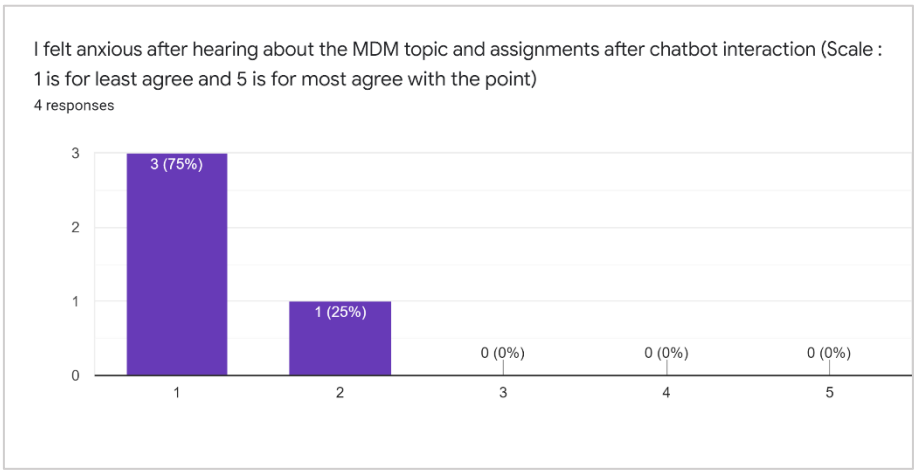



Figure 113 Chatbot group survey statement 10

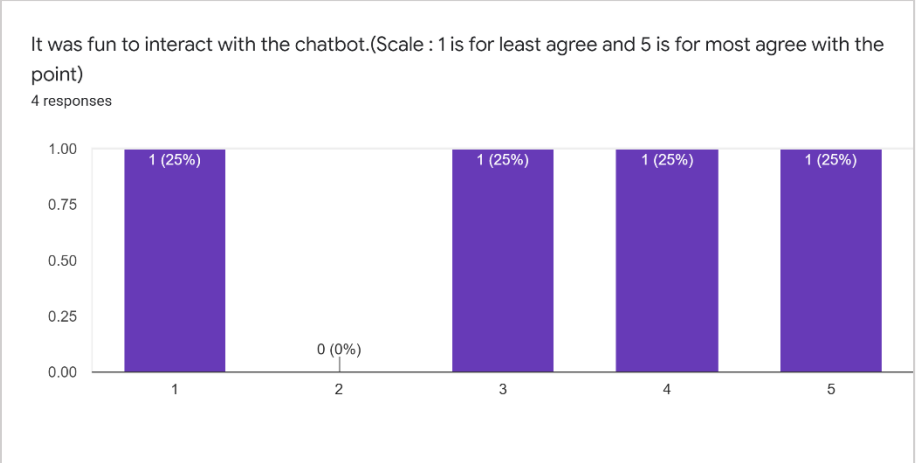



Figure 114 Chatbot group survey statement 11

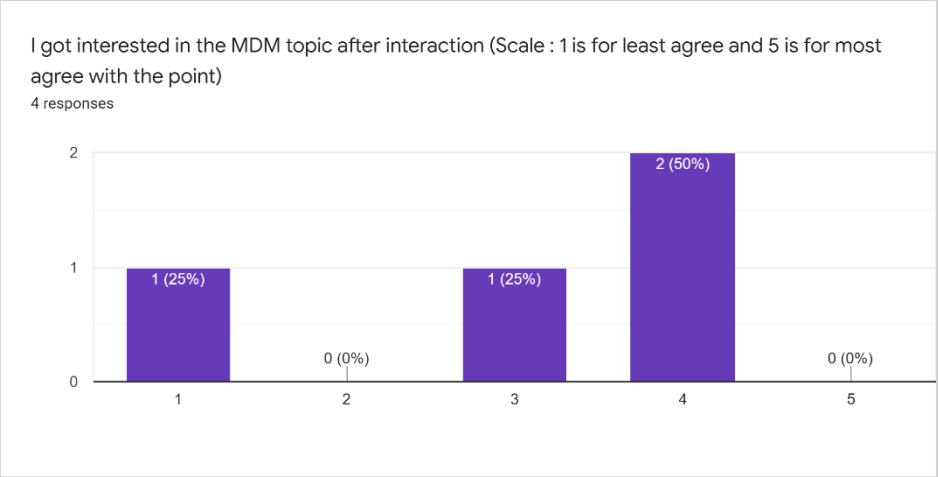



Figure 115 Chatbot group survey statement 12

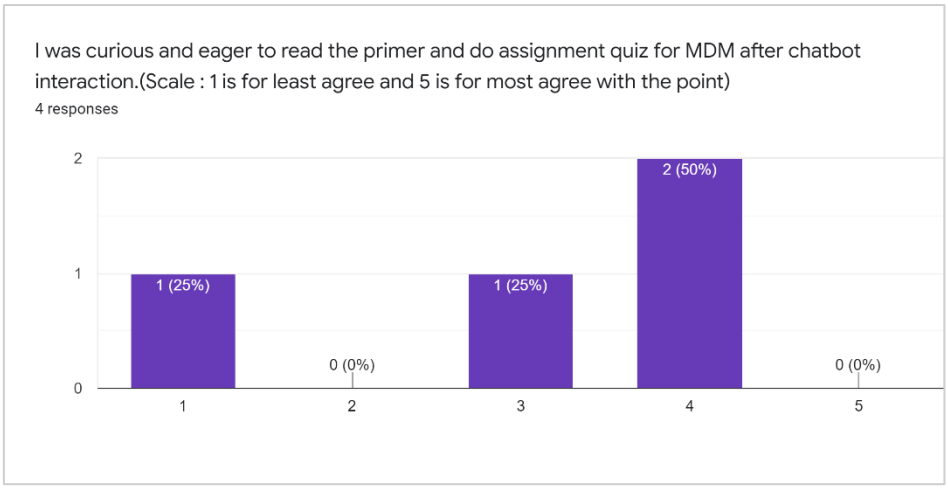



Figure 116 Chatbot group survey statement 13

## 8.5 Student survey results: Moodle group

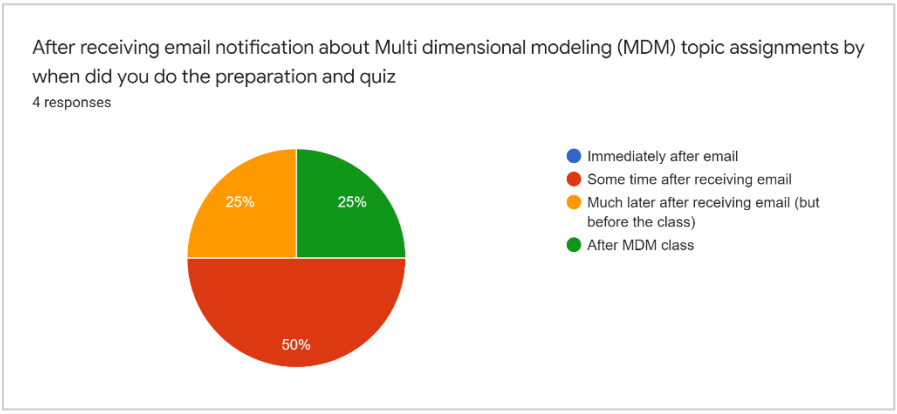



Figure 117 Moodle group survey statement 1

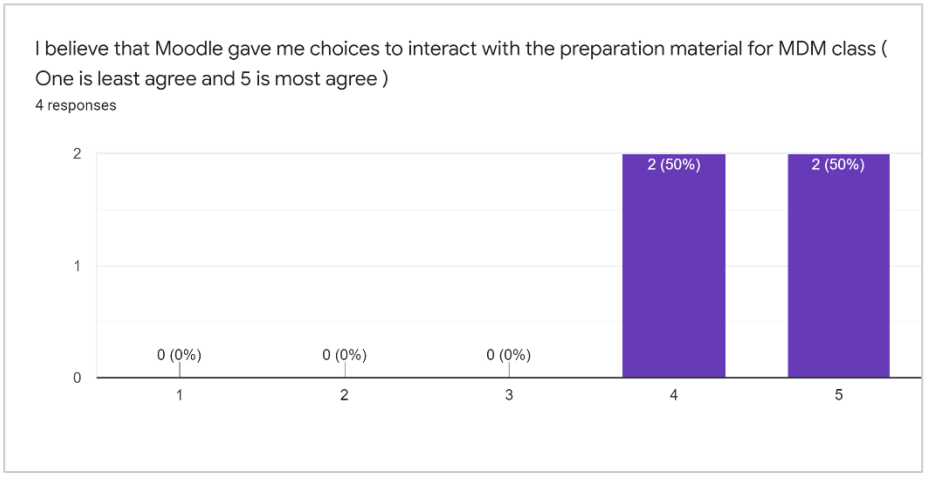



Figure 118 Moodle group survey statement 2

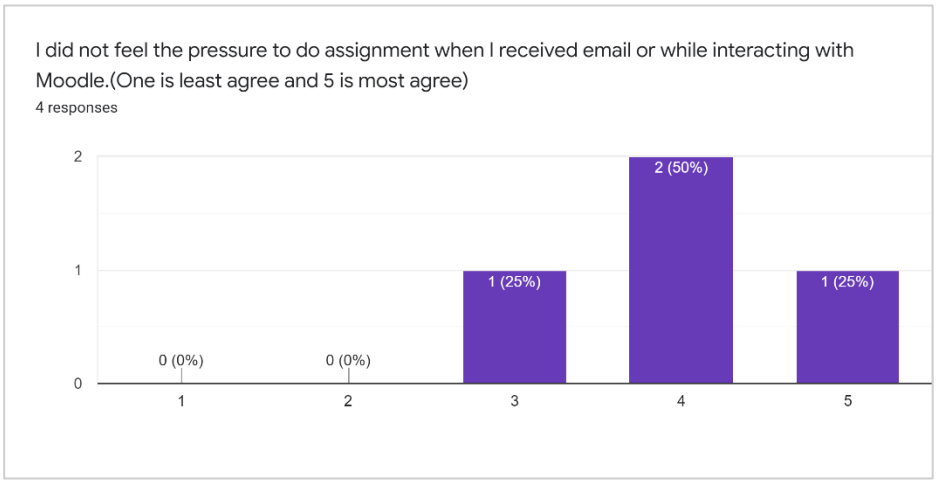



Figure 119 Moodle group survey statement 3

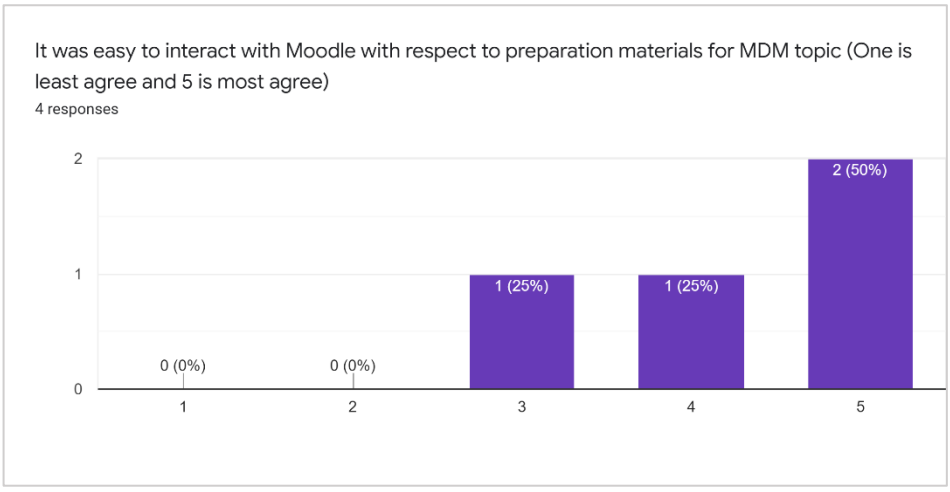



Figure 120 Moodle group survey statement 4

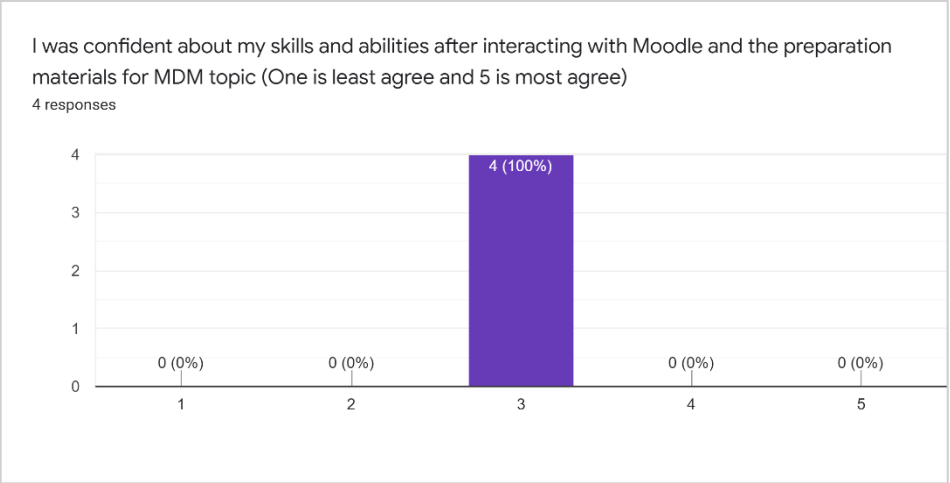



Figure 121 Moodle group survey statement 5

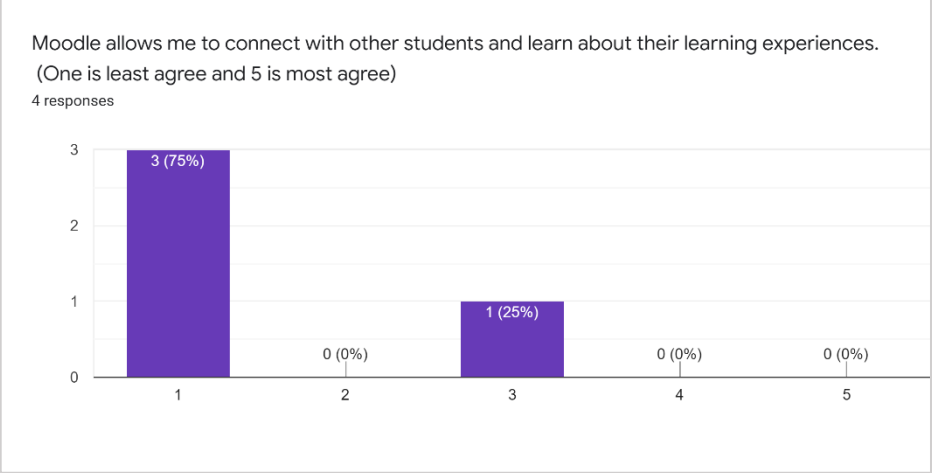



Figure 122 Moodle group survey statement 6

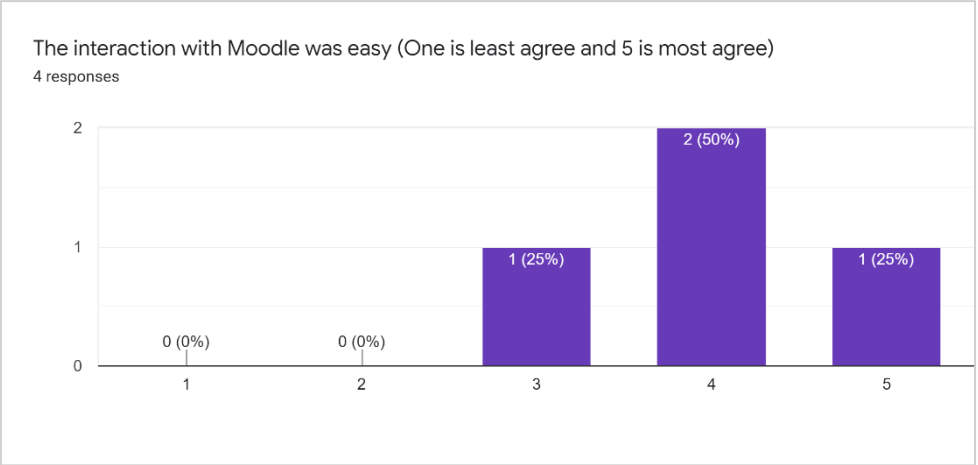



Figure 123 Moodle group survey statement 7

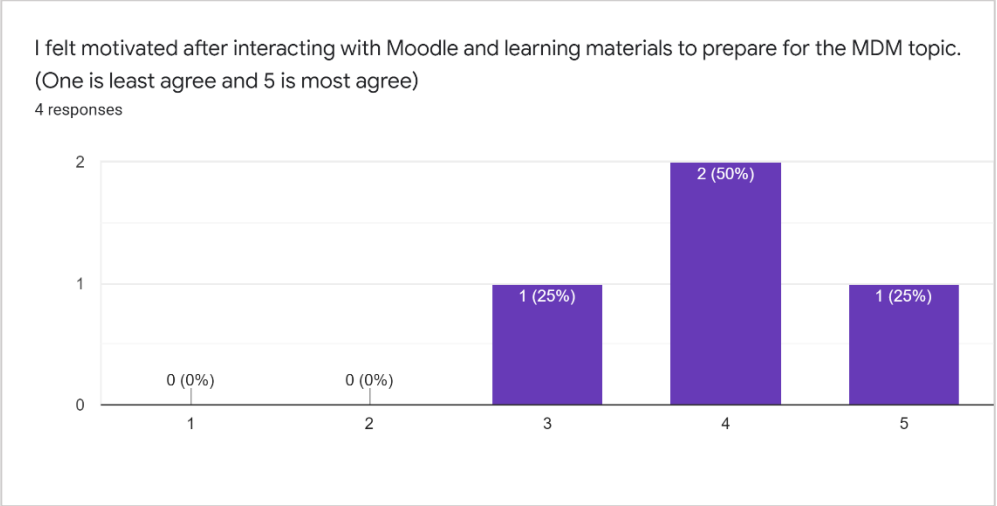



Figure 124 Moodle group survey statement 8

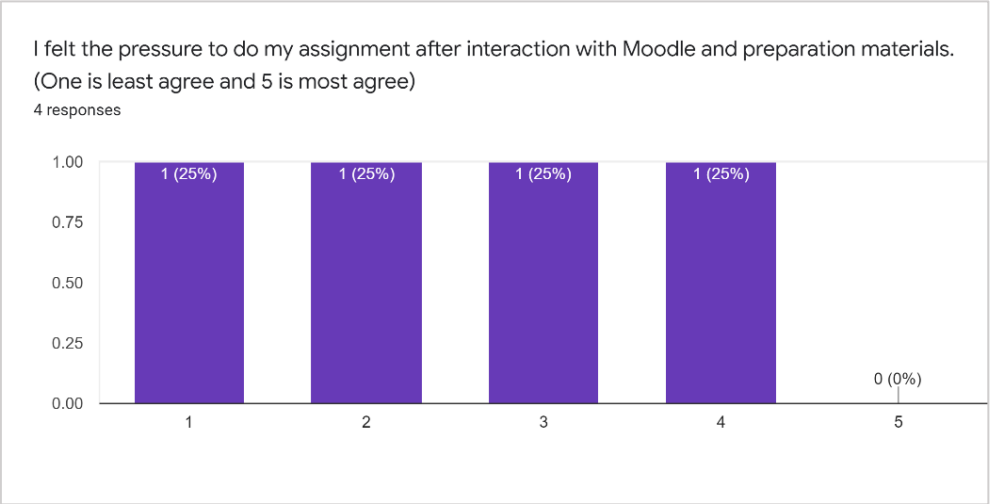



Figure 125 Moodle group survey statement 9

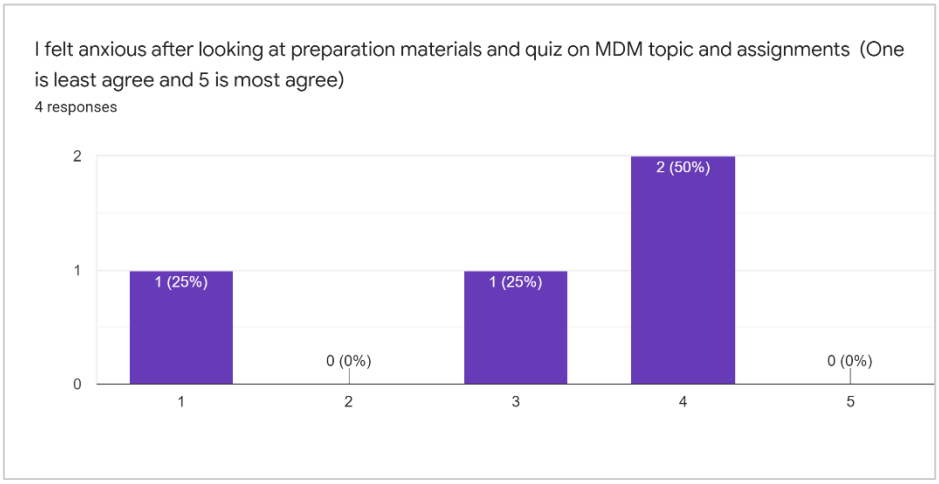



Figure 126 Moodle group survey statement 10

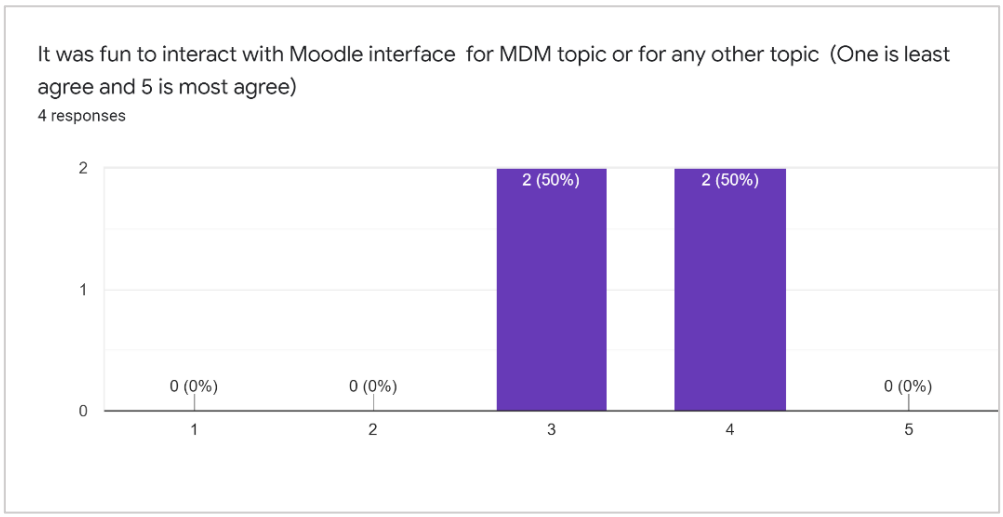



Figure 127 Moodle group survey statement 11

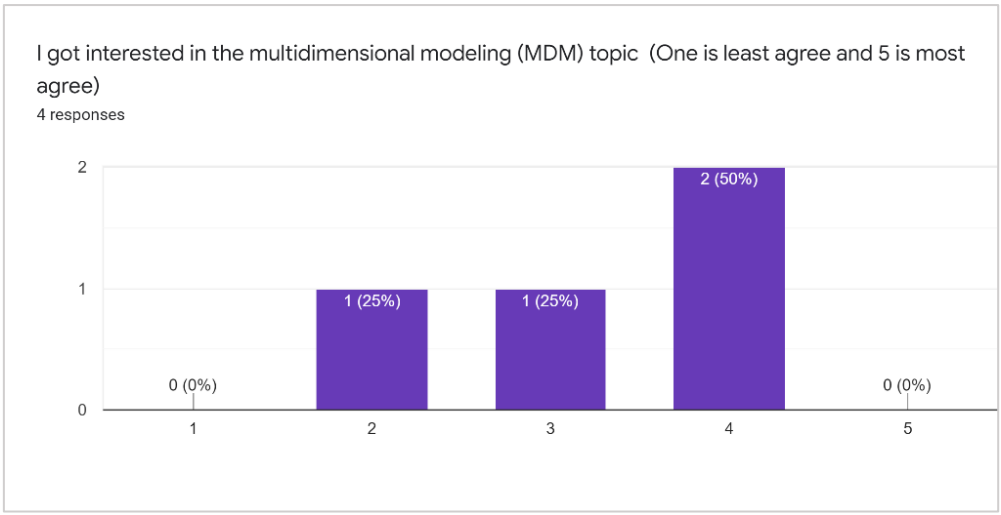



Figure 128 Moodle group survey statement 12

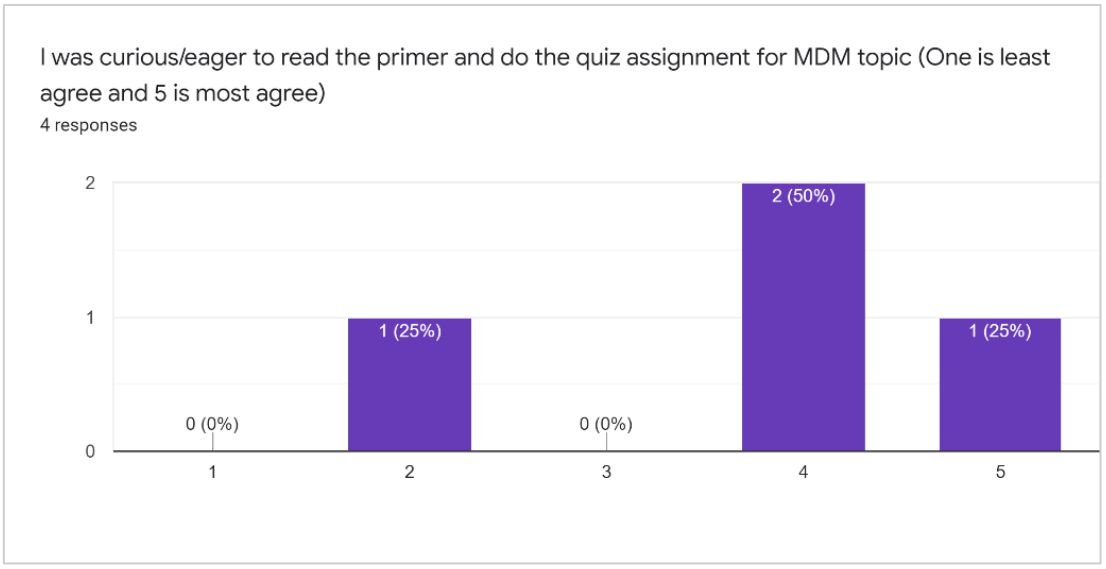



Figure 129 Moodle group survey statement 13

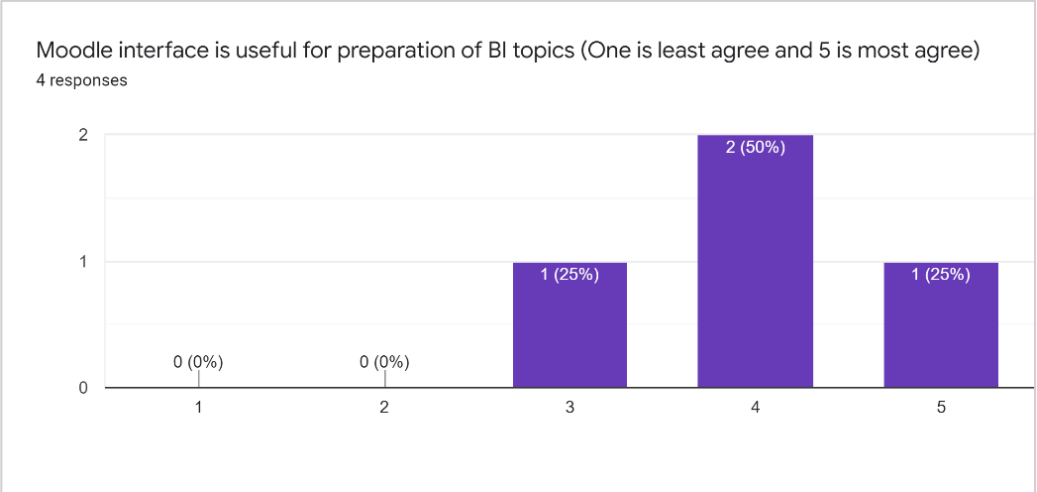



Figure 130 Moodle group survey statement 14

## 8.6 Online resources for similarity measures

1. Link for the professional level: https://www.indeed.com/career-advice/finding-a-job/work-experience
2. Links for the bachelor's degrees
    - CGSGRE_Taxonomy (ets.org)
    - Microsoft Word - CC2005-Final-06012006.doc (acm.org)
    - Taxonomy of degree programs
    - Business Engineering
    - Business Information technology
    - General Management
3. International Management
    - https://www.fhnw.ch/en/degree-programmes/business/msc-im?gclid=Cj0KCQjw852XBhC6ARIsAJsFPN0Vkst5hqyWrzgyAX0x4cHLXG5LspR_qM0CDe3Qba8GHP4otFq9tEcaAj0QEALw_wcB
    - https://www.fhnw.ch/de/studium/wirtschaft/ibm
4. Links for roles
    - IT consultant
    - Software roles
    - Business analyst

- Finance Analyst

## 8.7 Student evaluation interviews

The following interviews are from students in the test group that used and evaluated the chatbot Flippy. Initially, the students were given a small 5 mins demo of the existing Flippy chatbot features so they could remember their interaction with the chatbot. They were also provided with the chatbot link again so that they could go through it again. Then they were told to fill out the survey form based on their chatbot experiences. This is the evaluation form discussed in 6.2. In the last part of the interview, the answers given to the open-ended questions were discussed. Following are the questions and the answers from the student. Four students took the survey. While only 3 of them did the interviews. Prior permission from the students is taken for the usage of their data in the thesis work. Their names are kept anonymous.

| | |
|---|---|
| Name | Student 1 |
| Degree | Bachelors in business administration |
| Professional Role | Working in the financial industry |
| Question | Answer |
| Are you aware of the chatbot features? You explored most of the chatbots right? | I went inside and saw the different topics I could choose from. So I picked through the topics. And the first topic was to read the primer of Frieder you know and do the quiz. So I stopped again and I did this and went back then I went back to the chatbot. And then saw the different possibilities. But I didn't stay through all the points. |
| The student was then given the link to the survey form and the chatbot. The questions in the survey were discussed in 5 mins. The Likert scale was also discussed. The student was given the time to fill out the form. After the form was filled some questions were asked to the student. | |
| No question was directly asked but the student herself started to talk about the feedback from the chatbot. | Ya, I would like just two things. I am not sure if this is really what you are expecting. You have to tell me. But I remember when I did this chatbot interaction. If I want to see what was else the options that I could choose from. I also had to go to the beginning and then like going forth again. I would probably think its better if you can have a menu and then see I am here now. But then I can also choose between this and this and different topic… For me personally it wont have been better. |
| The student was asked about her opinion on customization and similar peer models and chatbot in general. | I this customization with the similar students and their experiences I think this is quite nice thing to do.Good idea. I like this very much. That is why I just wrote what I think could be improved for a chatbot. But it was an |

| | |
|---|---|
| | option that I find quite nice to have in the chatbot. You can relate you know. |
| The student was asked about any other opinion. For example if you could ask a question to the bot. | Yes. I know that its more difficult I guess to interpret because its semantic meaning. But I had this once. I had already with other companies chat interactions. And I really like it. We could write hey I want to do this? Where can I do it? And then like some suggestions came up. Yeah so |
| What sort of questions would matter to you ? Can you give some examples? Would be related to class or to the assignment? | More about the topic. Mayve there is one thing you didn't understand and maybe they can explain it. Or how can they show it? More about the topic. About what I have to do. |

Table 17 Student chatbot evaluation interview 1

| Name | Student 2 |
|---|---|
| Degree | Business administration |
| Role | Not working |
| Students were then given the link to the survey form and the chatbot. The questions in the survey were discussed in 5 mins. The Likert scale was also discussed. The student was given the time to fill out the form. After the form was filled, some questions were asked to the student. | |
| Question | Answer |
| The student was asked about her opinion on customization and similar peer models. Would it help to listen to experiences of similar students? | I think it would help but I think I would not only want experience from people who have same background. So I think like any experience any stories of previous students. |
| If you get would be good but also from different backgrounds? | Yes also from different backgrounds. |
| What about the rewards ? If you get the reward would you feel good about it? For example when you complete some assignment and then you get the reward. How do you feel about that? | I would definitely like that one. I think this kind of. There is a term for that. Making it like a game right? It was fun. I think it also fits the course very well because there are these escape rooms. So I think that is motivating just to see like OK I have now this stamp or this sticker here. |
| So you said the features you liked the most are the experience, the combination of text videos and possibility to select which way to approach the topic. Can you explain this points in more detail? | That's like a new topic for me. I had no knowledge about multidimensional modeling. So for me I think it would have been helpful to have even more basic detail like basic information about it. (more examples maybe) Yeah more examples. May be just like very basic very basic things. |
| So I would prefer the user to have options to scroll for more content ? | Yeah I think that would be good. Because someone to just skip it. They don't want to read it. But personally I like text. I like reading. So I would have liked. |
| Ok. Something small not very big. Something small content which you can it is not compulsary to read. Just basic stuff. More intelligent means can you give me some examples? Like do you want the possibility to ask questions? | I don't realise. I thought something and somehow it didn't understand me the way I meant. Or then I clicked somehow wrong pattern and it said bye bye. Even though I wasn't I didn't mean to leave there. I don't remember exactly but you are still working on it right. So may be.. |
| So basically more error handling sort of thing right? If there is any error it should handle it in a more easy manner ? | Yes yes. |

| | |
|---|---|
| The student was asked about whether she would like to use the chatbot for other important topics as well. | Yeah I would be happy to use it. And I think when you use it more times its also you know what it is about and you know how to operate. I think it makes sense to have it like not for every lesson but once a while there is an important new topic. |

Table 18 Student chatbot evaluation interview 2

| | |
|---|---|
| Name | Student 3 |
| Degree | Business Informatics |
| Role | Product Manager |
| The student was then given the link to the survey form and the chatbot. The questions in the survey were discussed in 5 mins. The Likert scale was also discussed. The student was given the time to fill out the form. After the form was filled some questions were asked to the student. | |
| Question | Answer |
| What would you like to improve? Can you please tell me? | Sure. So I just found it not very practical. It felt like the always the text is coming. And I had to click. Which felt like I am reading a very small text on a very big screen. So I had to hit the next button. And I didn't really see the added value of the chatbot compared to me just reading the text. And the problem was that at one point I stopped because I had to do something else and I came back and I hit the refresh button I even logged in and everything started from the beginning again.it didn't have the possibility to jump to the place I left off. And then I had to really click again through the whole thing. So I didn't really see the added value of the chatbot. That was really difficult for me. And was also difficult to jump back. |
| The student was asked again what could be improved in the chatbot in general for other students and for him as well. | Its very difficult to say the application of chatbot because as I said. I really didn't see the added value. I would somehow bring the video at the beginning. Right so you actually get the buy in directly. I think that's one thing. What was also not really clear to me is right at the beginning I was able to say click on different buttons what I want to do next so but I was unclear can I go back somehow ? I wasn't really sure where I am in the process. What my options are? So I think that something somehow could be improved. Maybe also it's a personal preference right but for me just acting like it's a chatbot that actually sends you predefined text felt to me like OK I just now need to hit the enter button the text is anyway there and it slows me down in reading. I would much more prefer of visualised kind of bigger text well also may have a graph and then text to it. OR video on the side. Something like that. |
| The student was asked if he would use it in the future for another topic if it is improved. | I think not because as I said when I compare it to lets say some rich text with some nice videos lets so of what you have the explaination of what is the bakground of it because I can just take the text. Its much more accessible for me. I can refer back to it. To the chatbot would be much for difficult. And I also didn't really see. For me it just felt like I am already motivated to do the next step so it didn't really add any value. I am curious about the topic so I want to go to the next thing. So it felt like what is the next thing? Why I have to do this to actually go to the primer or to the quiz. |
| This chatbot is not useful for students who are already motivated? | Yeah I think that's one part. And the other part is even I wouldn't know anything about it I think I would still prefer basically a text that gives me because Frieder's primer can be quite intense in context.So you are jumping right away. But if there there is a starting paragraph which tells me exactly the same thing where it is applied, whats the actual usage and whats the problems surrounding it ? I think I would prefer that more. |
| So maybe more text and a bigger interface? | Yes exactly. |

Table 19 Student chatbot evaluation interview 3

## 8.8 Links to the code and resources

The Java code for the peer modeling and the Flippy chatbot (Microsoft SDK) are stored in the drop box folder. The code contains the following features: -

1. A similar peer recommender system is integrated into the chatbot built with Microsoft SDK Java.
2. The links and the IntelliJ project are provided in Dropbox.
3. The code contains a read-me file on the installation process along with scripts for Arango DB etc.
4. It also contains links to other resources for the development environment etc.
5. The animated images used in the chatbots are from https://giphy.com/categories.
6. The code can be visited at the following Dropbox link:- https://www.dropbox.com/sh/b6vvrp7eup6sxol/AADNxKCh8-XPwR4o_wS_eXB8a?dl=0

The following images show the peer recommender system is invoked when the student inputs the profile data like the degree, role, professional level, and workload.

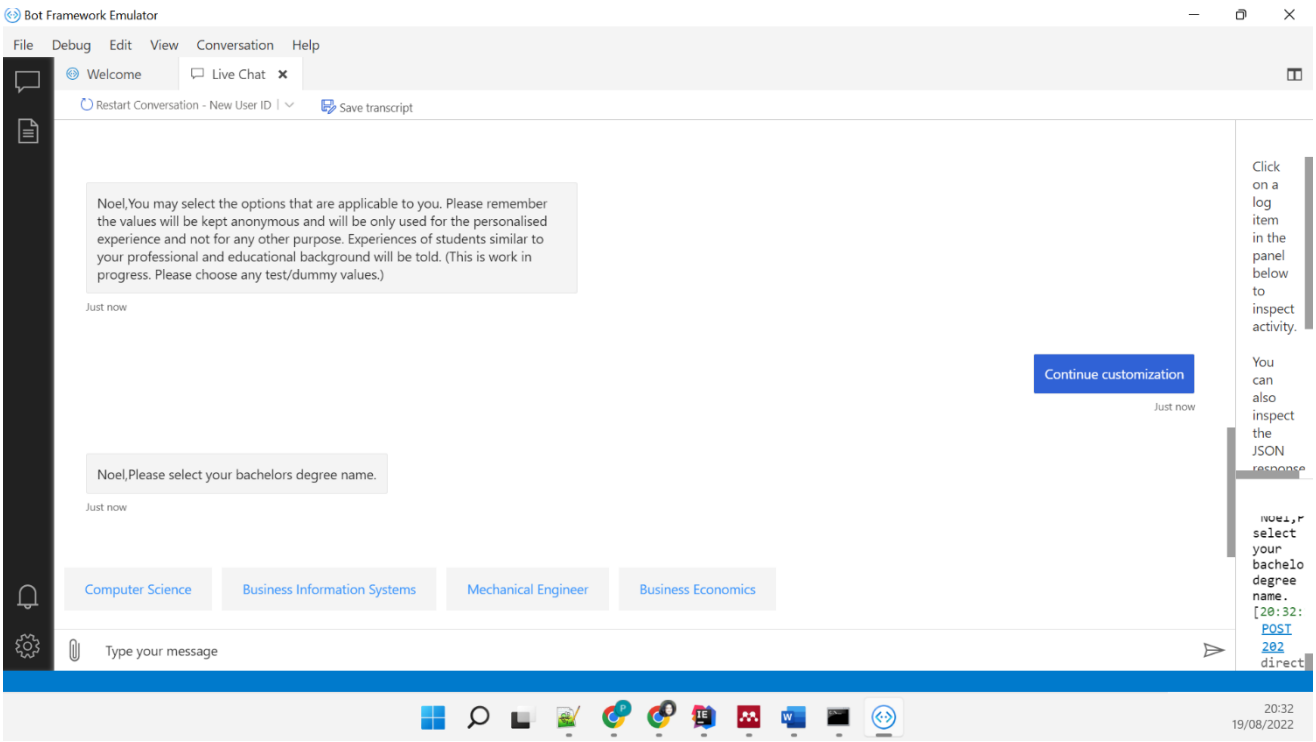



Figure 131 Flippy Microsoft SDK chatbot customization screen 1

Figure 132 Flippy Microsoft SDK chatbot customization screen 2

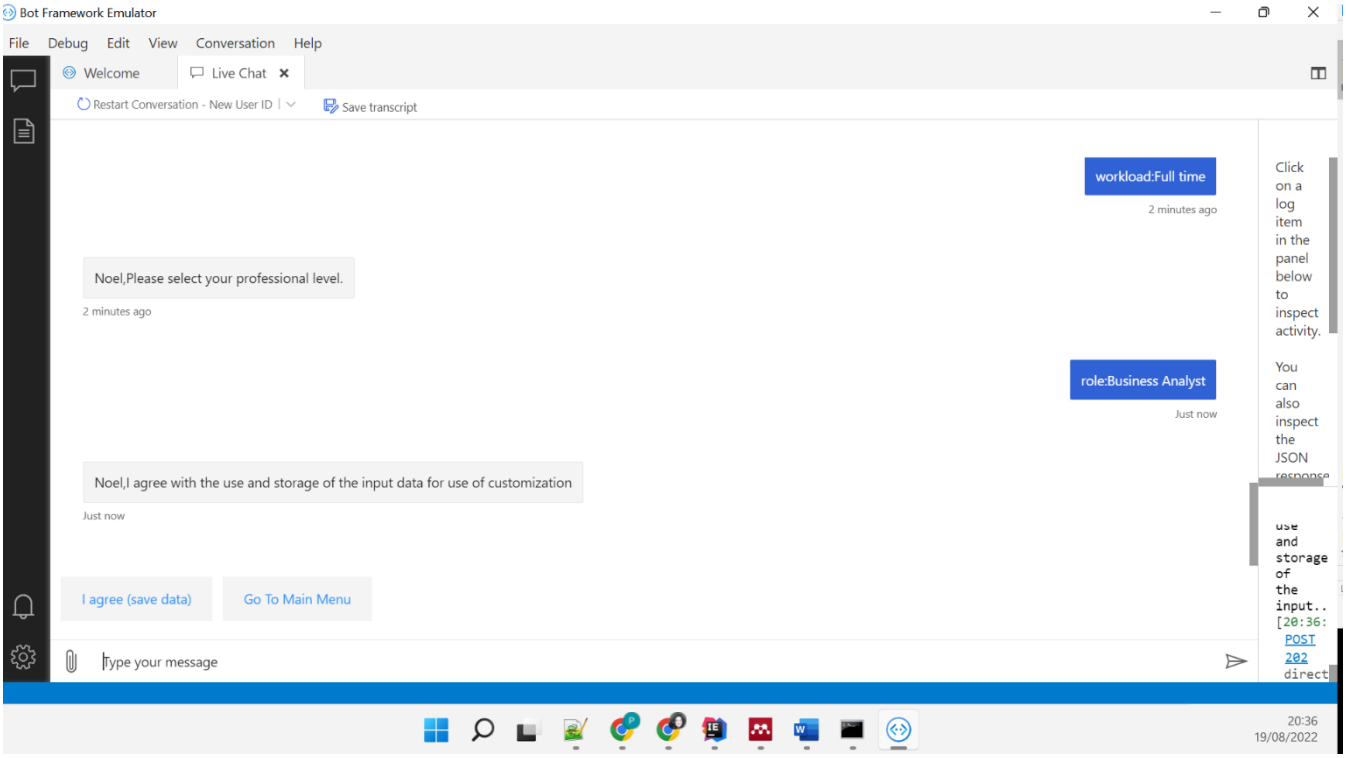
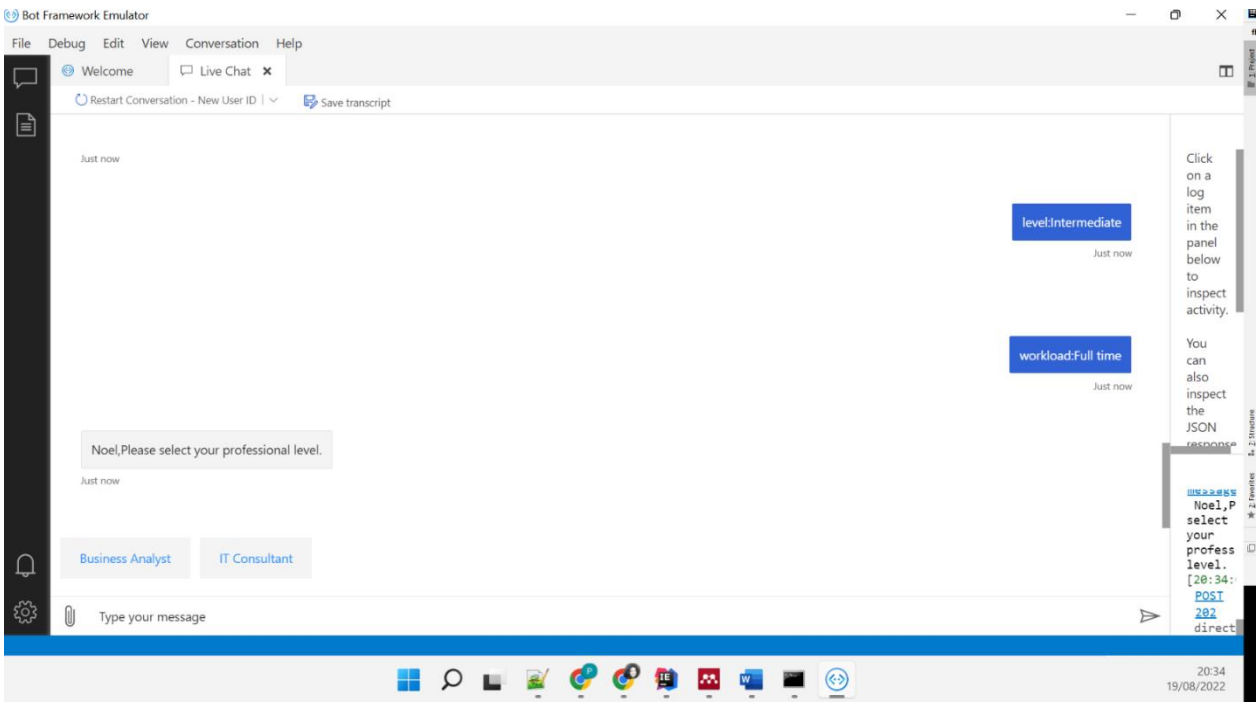



Figure 133 Flippy Microsoft SDK chatbot customization screen 3



In similar peers are found in the background by the recommender system as soon as the user saves the profile data in the chatbot. Refer to Figure 134 and Figure 135.

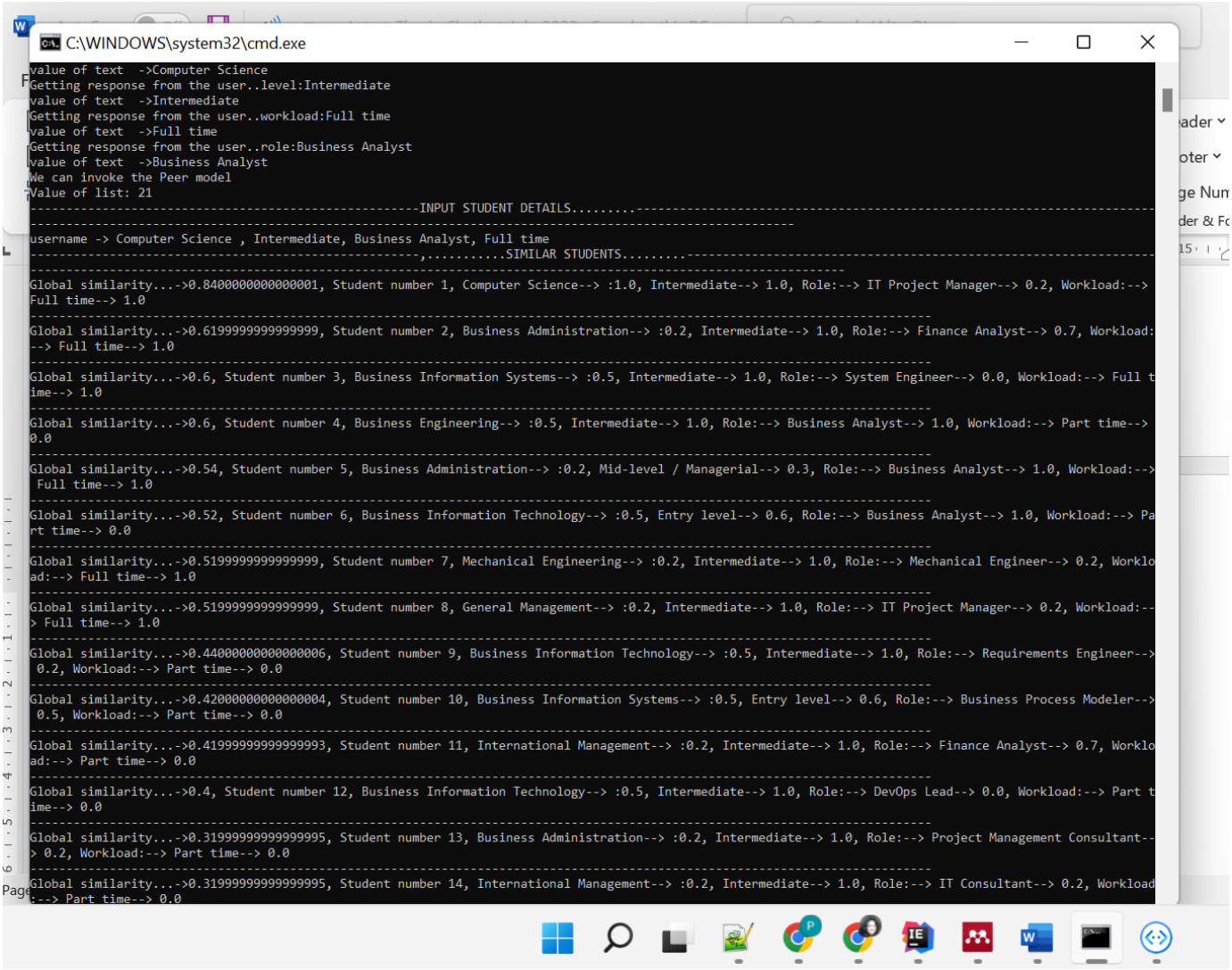



Figure 134 Similar peer recommender output for the input of student

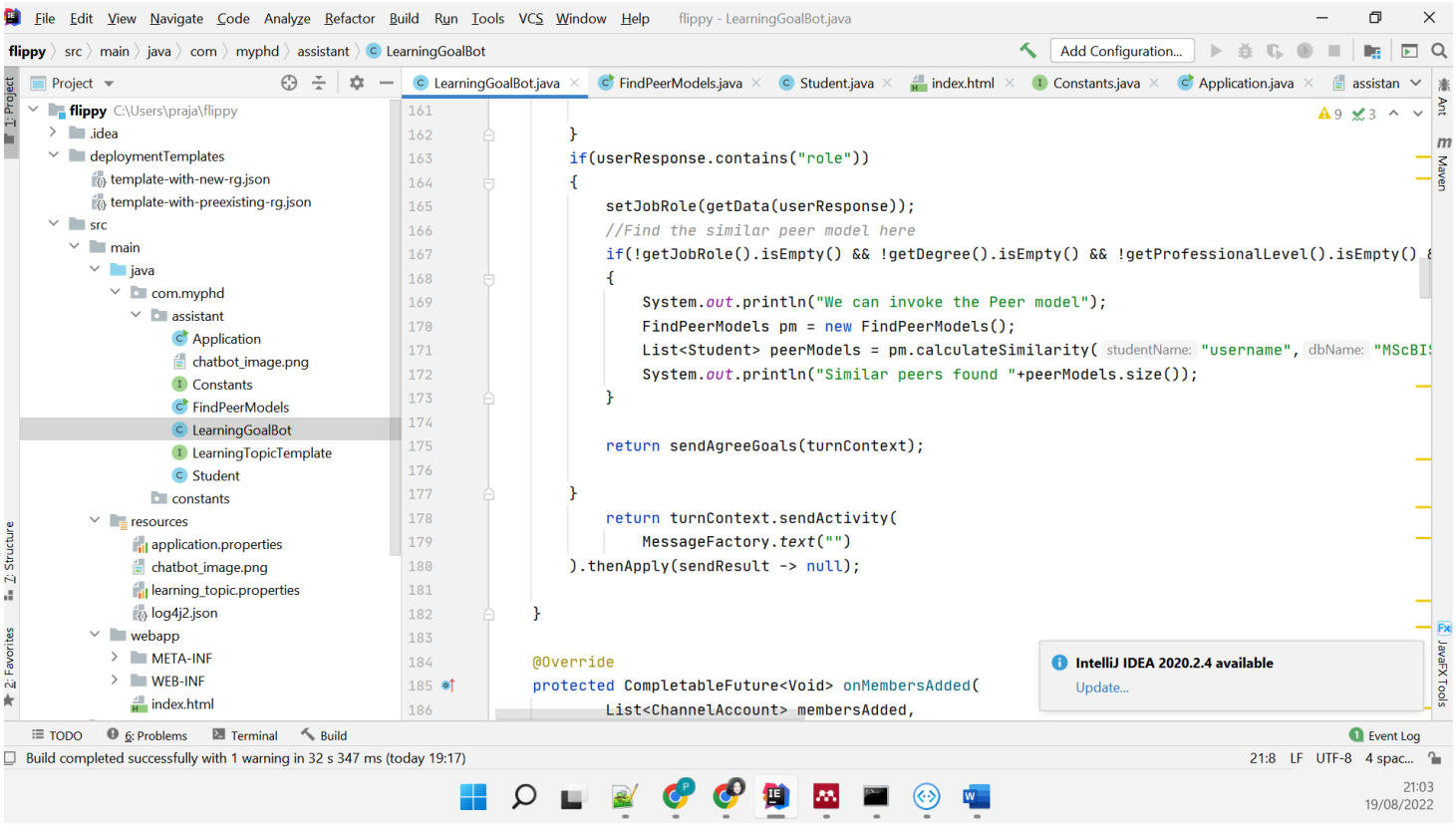



Figure 135 Flippy code integrated with peer modeling recommender system

Above Figure 135 shows the integration of a similar peer model recommender system into the code of the Flippy chatbot.

## 8.9 Answers to qualitative survey questions in a large classroom

Q1) Can you please provide a comment as to why you will use or not use the chatbot in the future?

A1) Students reply as comments below

interesting experience

if the *process* is cumbersome than google search

I found the bot friendly and informative

It can teach both with text and images, and can alleviate professor's work burden

I think it is good to know what needs to be done as preparation for class.

N/A

Takes some time to get to the direct point of interest.

I would use it. But I'm not sure if I would prefer it to a regular way of receiving homework, since with a chatbot I could not see right away the whole scope of homework. And for that reason many students didn't even realise we had homework at all.

i will use it because it is intersting.

I will use coz it is funny and good for education

I rather read the primer directly since it is well structured and make my own experiences with it.

I'm curious to explore upcoming topics

To find more deeper insight on any topic

I do not see the added value for myself using the chatbot.

no

-

I really appreciate the primers by Frieder. Therefore, I don't see any necessity for a chatbot in my case. It would be a good intro if there was just complex and unstructered literature available about a topic. The chatbot could function as a "soft introduction".

No benefit

Due to time and some other important activities

In my opinion the chatbot is not needed, the preparation tasks can be directly communicated via e-mail which saves time to interact with the chatbot. I could not really see sense behind it.

It's very easy to use, I think the way the answers are shown could be a little slower else it seems like you're going through it very quickly and removes an element of human interaction since the responses are so fast

Different approach to learning

Did not see the benefit for me as a student. At least in my experience it was a linear path through the topic wich could be done faster reading a pdf.

the chatbot appeared to me more like slides, that I clicked through with every answer

I would use it because it is an option to gather all needed information from one source which is also interactive. That way I think I would minimize my time to find information.

It is easy to get an overview over the topic

Chatbots are just not really interactive in my experince. They are to much focused on one topic/area. A real conversation is not possible and in that case, I can also just learn the stuff by my self or ask a collegue

For me a quick summary of the topic would be better suited to learn the basics as this interactive way, the options were often limited or did not match with one of my scenarios. E.g. I study Medical IT, could not be chosen in options But in general the playful interaction is funny to provide basic concept ideas

do not see any need

Maybe ok for pre-school but i feel like a this level it just slows you down when trying to get the information. More suited for exploratory problemns

I would not use the chatbot in the future since the answer seemed very generic and not personalised. It felt more like using an interactive UI then talking to a chat-bot. There where no options to directly ask questions. What i liked was how the chatbot organised the lecture information in an interactive way but i don't really see an additional benefit of using the chatbot in comparison to the moodle site, expect for the novelty factor.

It is a click thought chatbot, not open text interaction. It is fun to play with but it can not answer questions. I can explore the topic by clicking the given options, but I do not get the filling on where I stand in my progress: did I read all the important content, did I explore all the nodes, am I done?...

I prefer human interaction over chatbots - therefore less likely to use it

other style to learn

Chatbot provides fast and reliable answers.

because I am convinced that chatbots will be more common in the future

It is interesting and different

FAQ

n/a

I prefer to read longer texts with more explanation, and I feel I retain information better when I can picture where it was on a page.

Quickly responding

I will use again because of the story of experiences is very useful.

Q2) Which features do you most like in the chatbot?

| |
|---|
| ... |
| The GUI interface was warm. |
| Ease of use |
| overview about homework |
| Interaction |
| Opportunity to return the beginning, ease in usage, variaty of options, hyperlinks within the answer that directly takes to another platform. |
| easy to use and understand. It's an interesting and unusual way for students to prepare for lectures. Can't say anything about features, as they are pretty standard for chatbots. |
| answers well suited |
| just showing the materials from Teacher . |
| it lead me to the goal |
| interaction |
| weeing real-world examples |
| It's overview with options |
| multiple choices |
| - |
| speediness |
| - |
| Design |
| dynamic scroll down |
| most |
| Nothing stood out to me |
| Readibility |
| Reward |
| friendly |
| - |
| Interaction and good explaniation (pictures etc.) |
| clicking the diffrent paths, leading to the next interaction. I can choose with "way" i will go with the chatbot |
| none |

| |
|---|
| Playful like learning, quick and small important summaries that can be remembered easily |
| no idea |
| / |
| Interactive UI |
| It is easy to interact with, clicking options. |
| Not a feature but it's speed |
| not special |
| Quick response |
| accuracy |
| Easy to use |
| Quick response time |
| N/A |
| the student video |
| Different selection of topics and Information on next lecture |
| MDM cases |

Q3) What would you like to improve in the chatbot? Any other feedback or opinion with respect to chatbot features.

| |
|---|
| ... |
| None |
| When you click an option the page moves alone towards the next decision. I think it might be better if the page moved and get centered in the text that the bot has just diplayed, not it's answers. |
| _ |
| N/A |
| Possibility to type in your own requests (short cut) |
| I would probably add a warning for students that there is a homework inside. Could also be good to add how much time the homework would required - for example as in Confluence you can see the time you need to spend to read a certain page |
| - |
| - |
| all ok |
| I dont know |

| |
|---|
| nothing |
| Possibility to give free writing answers |
| Maybe bring more graphical insight on the topics |
| The Chatbot is okay but I do not see the added value in using a chatbot. |
| more randomize same answer on same topic |
| after 5 questions or so it just ended and i got the impression that this is it so I stopped doing anything but apparently missed some parts |
| No |
| Content, interaction, personalisation |
| no |
| More students' experiences, direct communication of the preparation tasks without clicking through to them |
| The speed of the responses are too fast |
| Search with open text |
| Interaction, ability to ask questions |
| Visualizations. And more precisely answers according to questions. |
| - |
| - |
| As mentioned above, I have used a lot of chatbots and until the AI is not really interactive (wich is not the case so far) I will not use it |
| The personalization, make sure to cover all possible values or provide an "other" option, Instead of asking all the time if I want to hear more maybe just have a more button to expand the information - so less questions |
| maybe some easy tests to be prepared |
| Level of education not appropriate. |
| Make it less generic and more personlised. I.e the ability to ask questions rather than a menu. |
| Maybe have a main agenda to cover and a measure of progress. Have the option the enter free text for questions. The chatbot shall figure out if I need more explanations, or give more details, or go back to review some topic. |
| I do not have a feedback for this |
| Integration in Teams |
| Broader spectrum of answers |
| higher responsiveness of more complex questions |
| Clearer answers |

| |
|---|
| Nothing specific |
| N/A |
| I am not sure. |
| More detailed explanation on New topics that students are searching for |
| increase the dimension of cases and varieties |

Q4) Please provide feedback for the above answer (related to student experiences via video and text). Students provided their feedback on why they liked/not liked peer model experiences.

| |
|---|
| ... |
| The video and text were very clear |
| Good |
| Other peoples expirience is not that important for me regarding preparation tasks. |
| I like most Video recored class |
| Video and pictures helps to keep attention spam, and text provides more detailed information. |
| - |
| vary the information format (videos) is positive |
| good |
| not really interesting |
| it was good |
| - |
| I couldn't find more added value than to a video or text |
| It was interesting |
| The Video should autoplay. |
| neutral |
| - |
| I didnt see other students experiences |
| did not see |
| good |
| I would have done the tasks anyway even without the student experiences |
| I like the visual charts presented by the chatbot |
| Good mix of media |
| Felt the experiences provided were good |
| - |

| |
|---|
| - |
| more varied than just reading |
| the video where intressting and usefull. Also for motivational purpose |
| The idea of providing a short video is nice, the content wasn't that interesting however |
| have not found it |
| I only realazided now that you can see the videos. flow not clear enough |
| no comment |
| na |
| I did like the video feedback of the students |
| like it |
| The delivered information were provided in an appropriate manner. |
| well understood |
| I liked it |
| It was good |
| N/A |
| I thought it was helpful to have the video from former students instead of only a text. I did not find the text that helpful. |
| No comments |
| I think it was not more effective and useful |

Q5) Please provide feedback for the above answer. Why you selected the above rating for the importance of topic etc. Students provided their opinion on why they liked/not liked the importance of the topic feature in the chatbot.

| |
|---|
| ... |
| I think they will help for a specific class but for wider topics it mmight not be as useful as doing your own internet research . |
| Correct order |
| It is not the most interesting topic in BI and I have no connection to it in real life. |
| N/A |
| Great. |
| - |
| Well explained |
| it will be easy to understand when visually presented. |
| real world usage are useful to make the topic important |

| |
|---|
| I think visual learning is more efficient |
| Especially Examples of real world usage are shown very good |
| It was a really short general description of MDM |
| It was important topic and was shown in the experiences |
| - |
| good |
| - |
| Easy to understand and helpful examples were provided |
| did not see |
| Number 3 |
| I would have better remembered the importance of the topic if I would have just read about it in the primer |
| Straight to the point |
| |
| I did not really feel that. In my opinion its much more exhausting to read in a chat format about a topic |
| - |
| - |
| it is a feedback in real time, how important the topic is and what can be done with this topic in de business world |
| n/a |
| Yes the message was delivered |
| doesn't looks smh serious |
| / |
| no comment |
| na |
| I think the choice of the topics was appropriate and helpful |
| Structure helps |
| Good choice of delivered topics |
| very helpful to get a better ubderstanding |
| ok |
| Feedback was ok |
| N/A |
| I don't think the short answers from the chatbot were helpful in explaining MDM, but maybe I expected too much from it. Longer texts are my preferred learning method. |
| I |
| section 3:Skills gained and how these skills will help the student?, could improve more |

Q6) Please provide feedback for the above answer. Why you selected the above rating for the rewards?

| |
|---|
| ... |
| There shouldnt be a reward. It should be called a badge or something similar to indicate you have the knowledge. |
| Insightfull |
| The reward does not mean much to mee. And it doesn't say anything about my skills. |
| n/A |
| Keeps motivated, increases interest to uncover the rest. |
| - |
| perhaps not necessary |
| - |
| Just for fun :-) |
| education is for learning not for warding with the points |
| I dont think a reward section is needed for a flipped classroom |
| It's a good, motivating idea, but there should be a check if the student really did the task. |
| Not required |
| I think on a master-level a reward-level is not neaded |
| not interessed |
| have not seen this |
| I didnt use it. When I heard "reward", I felt treated like a little child. |
| did not see |
| related to innovating skillls |
| Can't remember seeing a rewards section |
| No opinion |
| Funny |
| I did not understand how it worked |
| - |
| - |
| it is nice to get rewards just after i learned something, it motivates |
| N/A |
| I haven't visited it, and also here you should provide the "not visited" option |
| not relevant |
| Was not working? |
| I did not feel motivated by the reward system |
| na |

| |
|---|
| I am indifferent about this |
| Nudge can motivate |
| Valuable |
| liked it |
| I liked it |
| Was ok |
| N/A |
| I got an orange belt, but I don't know what that means, and I don't need gamification. |
| I |
| I think it was not more important |

Q7) Please provide feedback for the above answer. Why you selected the above rating for the customization?

| |
|---|
| ... |
| I think it is good to be albe to modify the student experience for furture users |
| I think it's ia good idea since it enable to prepare the cllass without much effor while taking a conversation. Instead of reading a 20 pages pdf i think that this soultion could be really usefull even for bachelora and high school students. |
| It is good, as there are different types of students. |
| N/A |
| I am very supportive of that. I think it can really add up to the learning expierence. |
| - |
| Considering the student background could increase efficiency |
| - |
| Could be interesting |
| functionality |
| Could be more extensive (more about personal interests), but I understand that it is a work in progress |
| That would be a really helpful feature |
| make sense |
| - |
| privacy concern |
| have not seen this |
| Didnt use it as it didnt catch my interest |
| did not see |
| i think it would be good initiate towards |
| I think this way I might would have taken out more of the chatbot experience |

| |
|---|
| How will you discern the different topics? Will it come through an entire structured DB with premade answers? |
| |
| I liked the experiences |
| This is what i expect from a chatbot. |
| - |
| unique experience while learning, personalized learning methods helps to learn more efficent |
| I like the idea, just be aware of DSGVO |
| Yes it is good to enhance it based on feedback, and the idea of similar backgrounds is good |
| it sounds useful, but not sure if it is possible to do good |
| in theroy good |
| I was first a bit taken aback of the sudden revelation, that flippy discovered students with a similar profile. This was not clear from the beginning, but in general i think a feature like this could be useful. |
| na |
| I think it's a great idea |
| customization helps to provide needed informations |
| Very useful |
| make sense to grt most out of data |
| I liked it |
| Good functionality |
| N/A |
| I do like the student videos and see that experience sharing as a useful part of learning. |
| Service ok |
| I think personalized experiences are good choice but it could be include different aspect and experiences. |

## 8.10 Case study data collection techniques

Data is collected and analysed from different sources in the FHNW case study. Activity logs from LMS on how the students solved pre-class quizzes were analysed for consecutive three years. Student surveys were conducted to understand why students skipped preparation and quizzes. Documents like module descriptions and preparation materials were also analysed to see the nature of the content delivered to students for class preparation. The theory of "*triangulation*" is used while collecting data from different stakeholders for defining the case study (Tibben, 2013). The triangulation method challenges researchers to adopt different strategies and methods to collect and analyse the data (Tibben, 2013). The thesis uses various data collection techniques to gather rich data from different perspectives mainly student-centric, preparatory, and technical aspects. Following are examples: -

a) Documents: Following documents are carefully studied while preparing the case study.
   - Anonymous student activity logs from the learning management system (Moodle) are studied carefully to understand the interaction behaviour of the students with the homework materials. The activity logs contain the interaction of students with learning materials and the logs of the pre-class quiz. These quiz logs contain information as to how students took the quiz, how many attempts they took, and the time to complete the quiz. While material logs contain what date/time the user accessed the preparation materials. But it is not possible to know from the logs whether the users read the material and how much time they spent reading it.
   - The structure of the learning management system i.e., Moodle is also studied to see what features it provides during solving the quiz and the preparation materials.

b) Surveys: Anonymous student surveys are conducted to understand how the students prepared for flipped classes and took the pre-class quizzes in flipped lessons.
   - A generic anonymous survey across all degree courses was conducted to understand the challenges and motivation levels in a flipped classroom. This survey was to find if there was a problem with preparation found in the flipped classroom from the literature review. In this survey, it was found that some students did not prepare for the classes because their workload was high; while for some the preparation content was too much; some had a lack of time while some lacked motivation and interest to prepare for the flipped class. The details are given in section 4.1.
     - The Moodle log analysis confirmed that the students did not take the quiz for reporting and dashboarding properly. They used trial and error methods to solve some questions and skipped answering some questions, while some users completely skipped the quiz. To understand the challenges of students in detail, an anonymous focused survey was conducted to understand how the students prepared and took the quiz for the "Dashboarding and Reporting" lesson in the *Business Intelligence* class. The reasons for not taking the quiz properly were some students did not get time to prepare; some students found the questions complex; some students did not know the steps to solve the questions, and some lacked the background knowledge to solve the quiz. The details for the survey are given in sub-section 4.2.3.
     - A survey was conducted to understand the background information of students to identify factors/features that could serve as similarity measures for recommending peer role models to students during classroom assignments in Business Intelligence Class. This survey is used for the development of the proposed proof of concept in the development phase.

## 8.11 Tools used for drawing figures.

The following tools were used to draw the figures in the thesis.

- Draw io: - https://app.diagrams.net/
- https://www.rawgraphs.io/

## 8.12 Improvements in the Chatbot

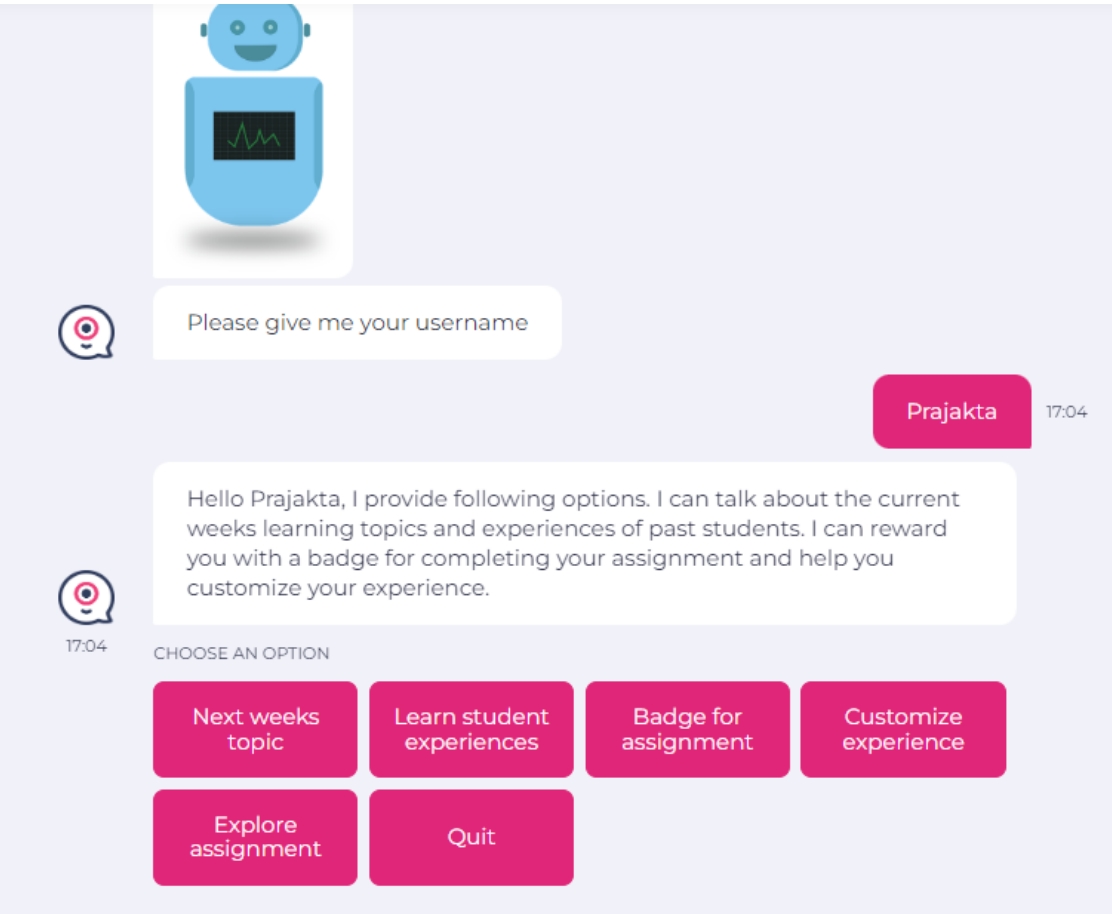



Figure 136 Adding peer modeling experience in the main menu.

Following improvements [21]are suggested based on the student feedback.

- Adding peer modelling experiences option in the main menu.
- Renaming reward to badge

[21] The images are designed in the tool Landbot : https://landbot.io/

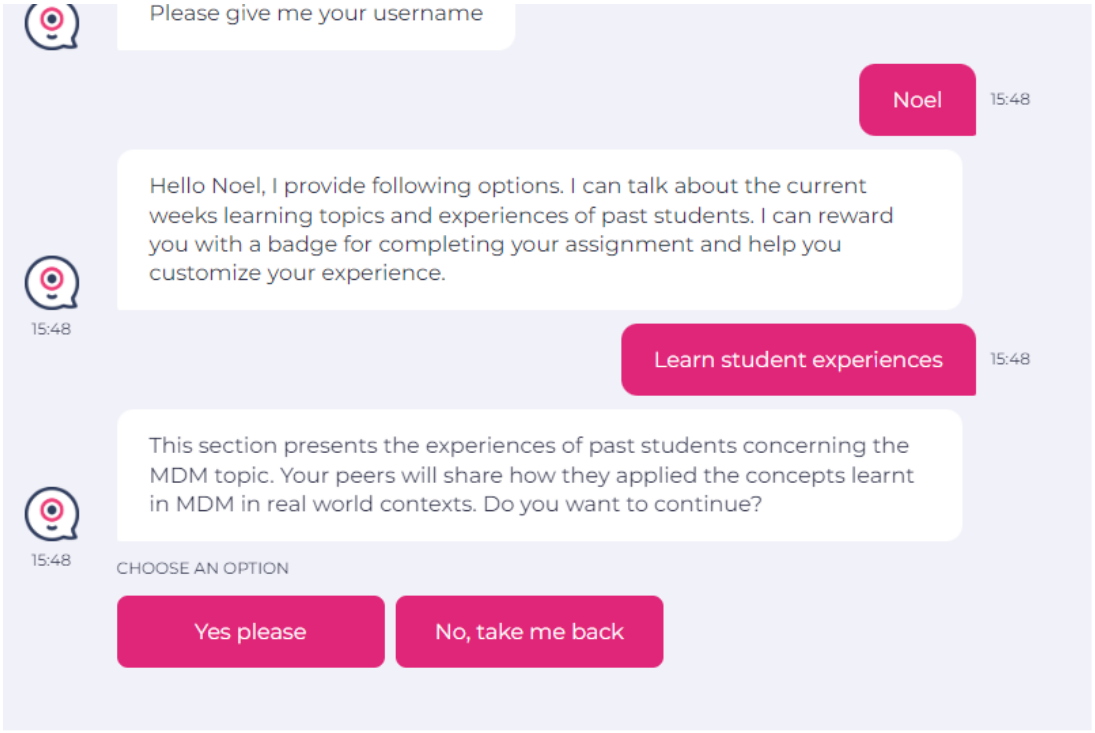



Figure 137 Peer modeling intro screen

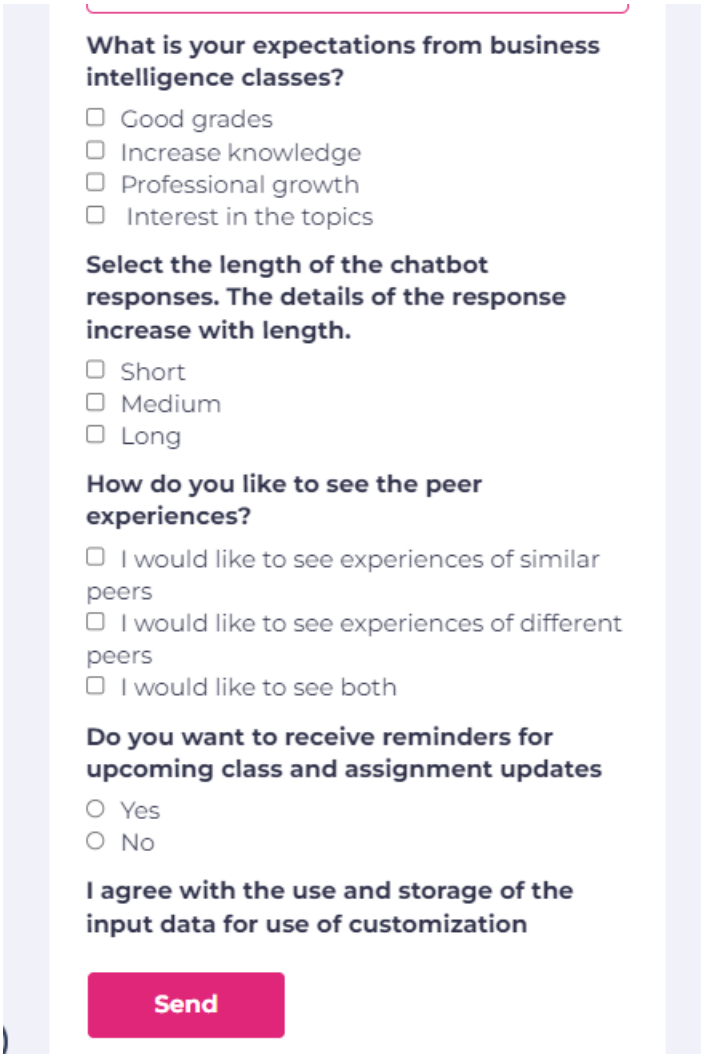



Figure 138 Customization with chat text length option

The following customization options can be added based on student preferences:

- Having the option to set the custom text length for the chatbot responses.
- Option to see peer experiences of similar or different backgrounds students.

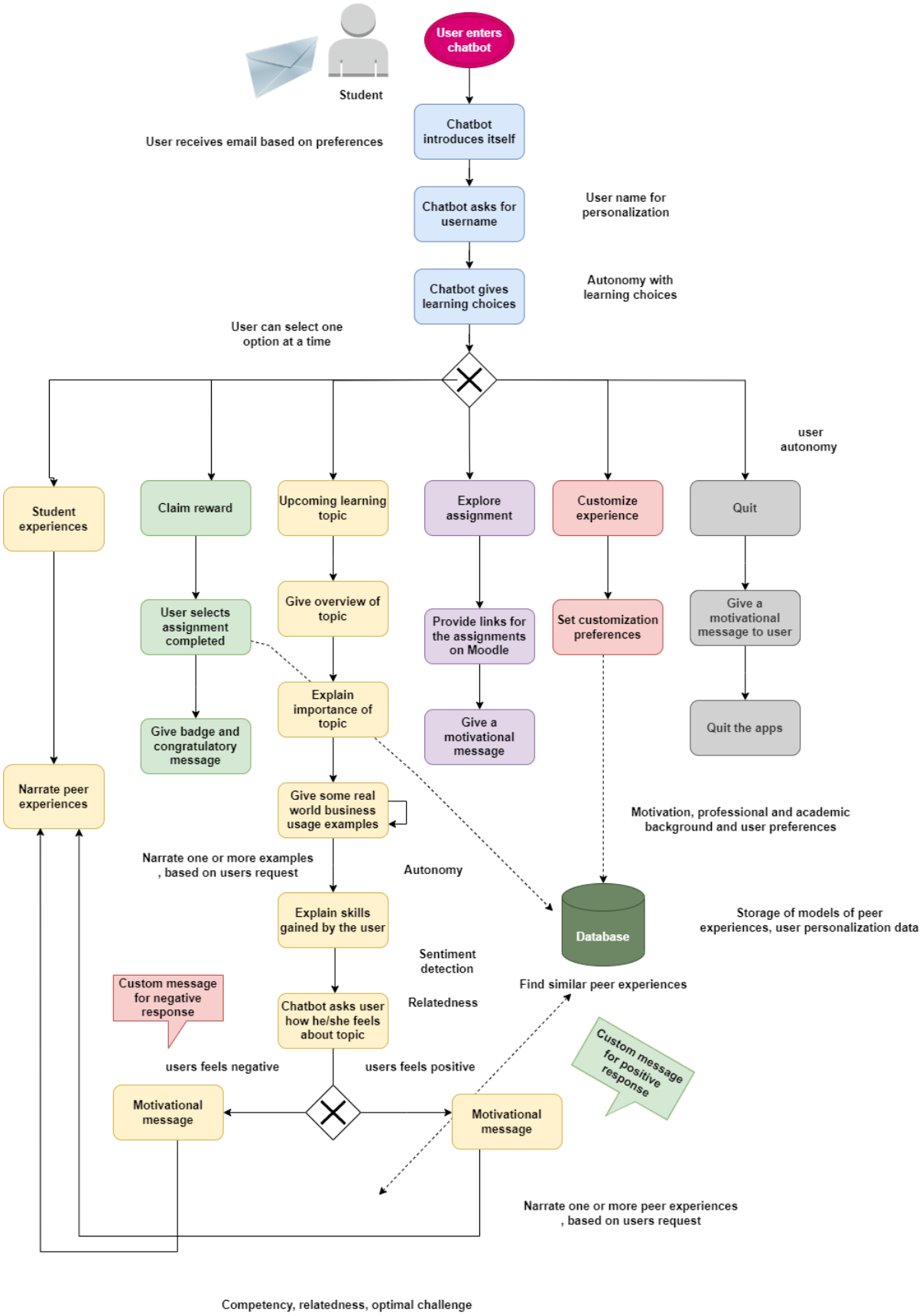



Figure 139 Improved chatbot flowchart with peer model option at the start

In Figure 139 the option of student experiences is at the start of the chatbot flow. The student can directly go to the peer student experiences from the main menu of the chatbot. The peer model experiences can also be seen after the learning topic introduction examples and skills.

## 8.13 Data analysis results

This is another way of showing the results presented in the section 6.3.


Figure 140 survey-based results concerning the students' emotional needs.

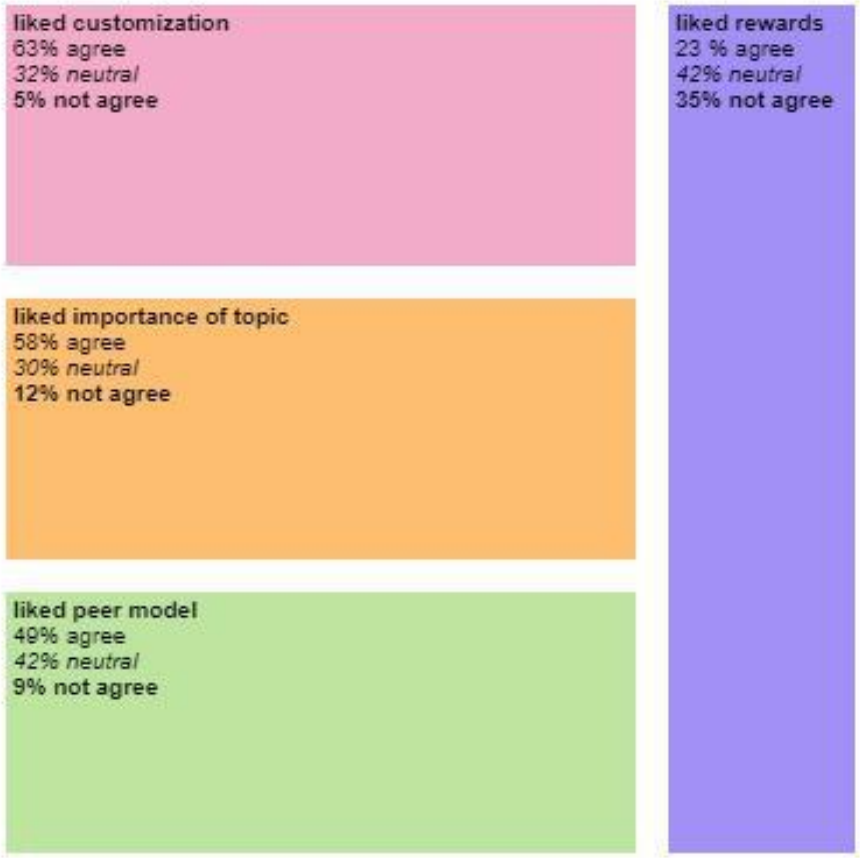



Figure 141 : Student ratings of features of Flippy