Implementing Audience Response System in Structured Mentoring Processes to Increase Learning Motivation

René Schmidt*, Ummay Ubaida Shegupta† and Wolfram Hardt‡
Department of Computer Engineering
Chemnitz University of Technology, Chemnitz, Germany
*Email: rene.schmidt@informatik.tu-chemnitz.de
†Email: ummay-ubaida.shegupta@informatik.tu-chemnitz.de
‡Email: wolfram.hardt@informatik.tu-chemnitz.de

***Abstract*—This research to practice full paper addresses the influence of Audience Response Systems (ARS) implemented into a structured mentoring process to increase the learning motivation of Computer Engineering students. One objective of mentoring in higher education is to encourage self-regulated learning by increasing intrinsic motivation. Motivation is an impetus for learning affecting the learner acceptance of the learning challenge and the introspective reflection on the learning process. In this study, the implementation of the mentoring process is shown by utilizing the ARS as a mentoring tool, implemented into the program structure following a structured e-mentoring process model. Furthermore, the detailed implementation of the particular process steps, which enables an evaluation of the entire mentoring process and providing the basis for future planning of the next mentoring process iteration is described. The evaluation of the methodology has been conducted over three semesters, with quantitative data collected by adapting the Academic Motivation Scale in the online survey to determine the influence of the ARS usage on extrinsic motivation, intrinsic motivation, and amotivation. Additionally, the usage frequency and the final grade are analyzed over the last five semester correlating survey results. The findings indicate comparatively higher intrinsic motivation than extrinsic motivation among the students and clearly indicate that ARS did not demotivate the students in learning. In consequence, the mentoring process, utilizing the ARS as mentoring tool, is implemented into an existing learning setting enabling the monitoring of the mentoring process resulting in an increasing learning motivation.**

***Index Terms*—Education, Computer science education, E-learning tools, Personalized E-learning**

I. Introduction

Learning motivation is the inherent belief to guide individual learning goals, induce learning behaviors to make continuous efforts, reinforce cognition history, and improve the learning outcome [1]. Adult learners' motivation to learn is fostered through differentiated mentoring approaches [2]. Mentoring is the process of personal and professional growth of a less experienced individual by a more experienced individual or by a more enriched learning assistance system [3]. It has been used as a strategy to enhance the academic, social, personal, and career outcomes for a range of young learners [4]. The primary goal of mentoring is to support mentees functions independently which is naturally overlapped with self-regulation [5]. Self-regulation includes the activities of setting goals, applying strategies, as well as cognitively monitoring performance and progress, while maintaining the motivation by utilizing available resources to achieve goals [6]. In this context, self-regulated learning is the self-regulation processes applied during a learning experience, where the goal is a certain level of achievement [7]. These processes are postulated to be important during mentoring interactions [8]. Consequently, the expectation can be derived that self-regulated learning before, during, and after the mentoring process represents an important role [9].

Mentoring provides informational, psychosocial, and instrumental benefits [10]. Informational benefits refer to the transfer of information and subject-matter, while psychosocial benefits refer to self-esteem enhancement, confidence building, and support for risk-taking that mentees gained from successful mentoring interactions. When mentors provide opportunities for mentees and uphold them with colleagues, then they are the beneficiaries of instrumental benefits. E-mentoring offers the same benefits [11], [12] and overcomes geographical and organizational barriers for personal interaction [11], [13] and for group e-mentoring [10]. Single and Muller [14] gave the definition of e-mentoring as a relationship that is established between a more senior individual (mentor) and a lesser skilled or experienced individual (mentee), primarily using electronic communications intending to develop and grow the skills, knowledge, confidence, and cultural understanding of the mentee to help him or her succeed, while also assisting in the development of the mentor. Based on this, structured e-mentoring is the process that occurs within a formalized program environment, which provides training and coaching to increase the likelihood of engagement in the mentoring process and relies on evaluation to identify improvements for the future and to determine the impact on the mentees [14]. These definitions are advanced on the work of the traditional mentoring and have recognized the importance of program structure to develop and implement successful structured men-

The authors gratefully acknowledge funding by the BMBF (16DHB2106).

toring process in which training and coaching are identified as dominant features.

One form to provide training and coaching is formative assessment in an ongoing mentoring process [15]. Because it gives the opportunity of formative feedback needed for provoking self-reflection and monitoring [15]. The scope of formative assessment and formative feedback in any learning process including mentoring can trigger motivation to learn [16]. According to the clearinghouse research of Cauley and Mcmillan [16], students learn more in formative assessment and feedback due to four reasons. Firstly, it allows both for fine-tuning of instruction and learner focus on progress. Secondly, it helps to ensure meaningful feedback. Thirdly, the formative feedback and reflection allow the mentees to see concretely how they can improve. And lastly, formative assessment is consistent with recent learning and motivation theories. E-learning and new learning technologies have created multiple opportunities like Learning Management Systems (LMS) to capture both performance and formative assessment data and can autonomously analyze them to support the mentor understanding how the students are progressing with various forms of activities and then discussing the feedback [17].

For this reasons, this research analyzes the influence of Audience Response System (ARS) as form of formative assessment methodology on students learning motivation when it is embedded in a structured mentoring process. Therefore, a ARS has been implemented in an LMS of the testbed institution as part of a structured mentoring process. The ARS represents a digitalized formative assessment system which is accompanied by face-to-face or online live discussion sessions.

In the following the used theoretical framework is described. Afterwards the used methodology is presented including the testbed description, the detailed implementation of the mentoring process and the used quantitative mentoring assessment methodology. Subsequently the results are presented, followed by discussion and conclusion.

II. Theoretical Framework

A. Structured Mentoring Process

Lev Vygotsky's social learning theories are the basis for mentoring as an effective means toward higher levels of cognitive development [18]. According to his theory, learning only occurs with the assistance of a skilled and nurturing mediator who can be assumed as mentor [19]. Effective discussion recognized as scaffolding during the training phase requires the mentor to lead the mentee into the zone of proximal development (ZPD), a concept describing the difference between the learner's actual level of development and potential level of development with guidance [20]. As the mentee proceeds through the ZPD, the mentor initially provides direct supervision and guidance but, more importantly, assists to develop self-regulating behaviors [20]. These self-regulating behaviors enable the mentee to gradually perform without mentor's support [6] and eventually to automate and sustain the newly learned capacity. Traditional mentoring is used as a form of professional development, frequently it occurs within

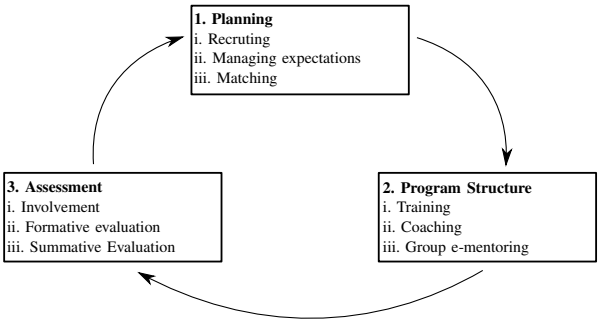

Fig. 1. Model of Structured E-mentoring by Single et al. [10].

the same organization, and the mentors serve as supervisors or managers to the protégés or mentees [21]. Even when the mentees are not reporting directly to the mentors, but are in the same organization, the mentors' assessments and judgments of the mentee can have influenced on the mentee's professional advancement [21]. University students often are hesitant to expose their deficiency in knowledge or self-doubts to lecturers or mentors in positions of influence over their academic careers. Though research on face-to-face mentoring programs supported this concern, e-mentoring provides support to the value of impartiality [10].

A structured method to implement an e-mentoring process is presented by Single et al. [10], which describes a framework for presenting essential features to e-mentoring programs. It describes the process as a circuit of the three phases planning, program structure, and assessment depict in Fig. 1. In the planning phase recruiting, managing expectations of the participants, and matching e-mentoring pairs are conducted. The program structure phase includes the steps taken while the e-mentoring program is being operationalized. These steps are training, coaching, and group e-mentoring opportunities that foster involvement in the e-mentoring process. The final assessment phase focuses on examining and assessing whether the program phase elements are effective and if the overall process is achieving its objectives. For the purposes of current study, the program structure phase focuses on formative assessment and feedback discussion by means of training and coaching. This framework of mentoring by Single et al. [10] emphasized the importance of providing training for mentees. Training takes the form of face-to-face or online orientations that coincided with the commencement of the mentoring program [12]. While e-mentoring programs implemented training differently, all the variations on training served to get the e-mentoring relationships off to a good start. Following training, coaching is offered which is referred as facilitation by providing feedback about the existing knowledge and skill of the mentee [22]. While the training and coaching features of e-mentoring programs support involvement within the mentoring pairs, it renders the opportunities for group e-mentoring. Group e-mentoring allowed the participants to benefit from the wisdom and encouragement of others [10]. When group e-mentoring relationships did not meet the needs of the participants, group e-mentoring provides safety net and

allowed participants to 'listen in' and learn from other peer mentors and colleagues [13].

In this study the program structure phase of the structured mentoring model is implemented to motivate the students in the testbed so that they can get the scope of being self-regulated learner. Motivation is the psychological process that initiates, guides, and maintains goal-oriented actions and involves the biological, emotional, social, and cognitive forces that activate behavior [23]. Educational psychologists have proposed the same ways of thinking about learning motivation like classical motivation which includes exploring whether motivation arises from outside (extrinsic) or inside (intrinsic) of an individual [24]. Extrinsic learning motivation arises when students perform a task or learning activity to earn a reward or avoid punishment, while intrinsic learning motivation arises when the mentee perceives it as rewarding to perform this learning activity.

B. Self Determination Theory

A framework for educational settings addressing the factors of intrinsic motivation and autonomous extrinsic motivation directly is the Self Determination Theory (SDT) [24]. As an organismic theory of motivation, SDT assumes learners are inherently prone toward psychological growth and integration, followed toward learning, mastery [23]. However, these tendencies are not automatic, they require supportive conditions [23]. SDT suggests that students are motivated to grow and change by three particular fundamental, innate and universal psychological needs namely those for autonomy, competence and relatedness [25]. Autonomy refers a sense of initiative and ownership in one's actions, competence indicates the feeling of mastery, a sense that one can succeed and grow and finally, relatedness concerns a sense of belonging and connection [23]. Accordingly, SDT's analysis of learning settings is primarily focused on the extent to which they meet or frustrate these basic needs [24]. From these concepts the first key assumption of the theory is that learners are actively directed toward growth by gaining mastery over challenges and taking in new experiences to develop a cohesive sense of self [26]. The second and final assumption states SDT focuses primarily on internal sources of motivation such as a need to gain knowledge or independence [26]. The use of SDT in this study is in response to including ARS in the program phase of structured mentoring process to guide not only processes and support functions aimed at individual mastery (i.e., autonomy and competence), but also those aimed at interdependence with the feedback of mentor and discussion of the group (i.e., relatedness) [26]. SDT provides the basis of implementing the mentoring opportunities to satisfy these three basic needs facilitate mentee's learning motivation and effective functioning [27].

C. Social Cognitive Theory of self-regulation

According to social cognitive theory, human behavior is extensively motivated and regulated by the ongoing exercise of self-influence [28]. The major mechanism of self-regulation operates through three principal subfunctions [29]. These include self-monitoring of one's own behavior, its determinants, and its effects; judgment of one's own behavior in relation to personal standards and environmental circumstances; and affective self-reaction. Self-regulation also encompasses the self-efficacy mechanism, which plays a central role in the exercise of personal agency by its strong impact on thought, affect, motivation, and action [28]. Students cannot influence their own motivation and actions very well if they do not pay adequate attention to their own performances, the conditions under which they occur, and the immediate and distal effects they produce [30]. Therefore, success in self-regulation partly depends on the fidelity, consistency, and temporal proximity of self-monitoring. The process of self-monitoring is not simply a mechanical audit of one's performances. When students attend closely to their performances they are inclined to set themselves goals of progressive improvement, even though they have not been encouraged to do so [30]. This goal setting enlists evaluative self-reactions that mobilize efforts toward goal attainment. Knowledge of how one is doing alters one's subsequent behavior to the extent that it activates self-reactive influences in the form of personal goal setting and self-evaluative reactions [30]. Bandura's [28] social-cognitive learning theory views human functioning as reciprocal interactions between behaviors, environmental variables, and cognitions and other personal factors. According to this, students are engaging in activities, receiving feedback and participating in other forms of interaction in public, social contexts [31]. This theory assumes that if there is close identification between the learner and the intervention accompanied by high self-efficacy, learning is most likely to occur [28].

The characteristics of Social Cognitive Theory are inherent within an effective mentoring relationship, which looks to match mentee and mentor based on similar interests and backgrounds [32]. The role of the mentor and the willingness of the mentee are crucial in the context of mentorship [33]. Accordingly, mentors are responsible for creating a climate in which learning is valued and mentoring is a communal responsibility. Therefore, mentoring can be viewed as a form of social cognitive learning. Thus, Social Cognitive Theory helps explain mentees' advanced capacity for observational learning that enables them to expand their knowledge and skills on the basis of information conveyed through modeling influences [33]. Bandura [28] suggests that educational institutions represent the places where students develop cognitive competencies and acquire the knowledge and problem-solving skills essential for participating effectively in society. In contrast to this theory students tend to select activities and associates from the varying range of possibilities in terms of their acquired preference competencies [30].

III. METHODOLOGY

A. Testbed

Testbed for the evaluation is a seminar to learn scientific working methods covering the learning outcomes of a wide range of competencies required in the field of computer

engineering following the competency model of information technology (IT) industry [34]. In particular, the competencies in the tiers - Personal Effectiveness Competencies, Academics Competencies, Workplace Competencies and Industry-Wide technical Competencies are addressed and trained. The course consists of three parts. In the first part of the course, students are taught the theoretical background of scientific literature research, professional presentation preparation, professional presentation techniques, discussion techniques and scientific reporting. On this basis, the evaluation criteria for grading are derived, weighted and transferred into a standardized evaluation sheet calculating the final grade.

In the second part of the course, students conduct a literature review on an chosen topic of a set of predefined practical topics. Every topic can be chosen by one student only. Thereby they train the theoretical basics from the first part and apply them to a concrete example. Subsequently, the student will prepare and present a presentation on his or her research in front of the other participants of the course as well as two examiners. Each of the examiners grading the presentation and the following discussion about the topic by filling out the prepared evaluation sheet. Afterwards both examiners provided the student feedback to improve the presentation performance and tips for the report preparation.

In the last and third part of the lecture, the students are writing a scientific report on the topic they have already presented. The report has to be submitted digitally and is evaluated by one examiner, who is filling out the corresponding evaluation sheet. The final grade is derived by the sum of the averaged presentation results of the two examiners and the results achieved in the report. Thereby 50 points can be achieved for both the presentation and the report, leading to a maximum of 100 points.

For the present study, the last six semesters are analyzed, where the first summer semester (SS) of 2019 is considered as a reference for data analysis only. The implementation of the technologies and the didactic setting took place for the first time in the winter semester (WS) 2019/20, where the acceptance of the technology was evaluated. The acceptance analysis results of ARS as blended mentoring tool are published in [35]. In the subsequent SS 2020, the mentoring process described in the following was implemented for the first time and evaluated over the semesters until SS 2021. Furthermore, in mid of WS 2019/20 the corona pandemic started leading to a changing of the lecture style from presence teaching to complete digital teaching starting from SS 2020. The number of course participants varied between 70 and 85 students per semester.

B. Mentoring Implementation

The main idea of using the ARS for mentoring to increase the student motivation is to integrate the ARS into the mentoring process model provided by Single et al. [10]. Thereby, the ARS tool is embedded in all three phases of planning, program structure and assessment. In the planning phase, the ARS content is set up and updated according to the previous assessment results. Furthermore, The ARS will be integrated into the university LMS and configured to be accessible only at the time of the corresponding lecture. Moreover, new QR Codes and short-links are generated to enable easy and efficient access via browser or QR code scanner.

In the program structure phase, the ARS is used as a didactic tool, as it has been implemented in previous works, which proved the tool's acceptance and described the didactic and contextual concept [35]. Therefore, the same four ARS tests are implemented equally according to the ZPD concept and following the scaffolding technique. In consequence for every main field of study one ARS test is directly conducted in the lecture. The respective ARS tests focuses on reflecting the understanding of the learning outcomes by applying them to real-life scenarios, which has been inspired by common mistakes from previous semesters. This addresses the application level of the cognitive domain of Bloom's taxonomy and provide the basis for discussion of common errors directly in the lecture and the related resolve of potential misconceptions. At the time of the discussion, the instructor takes the role of mentor and guides the students to the correct understanding by directly addressing the mistakes made by the participants.

In the final assessment mentoring process phase, the mentoring process itself is evaluated. Therefore, two approaches are used to evaluate the students motivation. On the one hand, a survey is conducted with the help of a questionnaire and on the other hand, an assessment data analysis is carried out. Both evaluation methods are described in detail below.

C. Quantitative Mentoring Assessment

1) Survey Design: A survey has been developed to collect the data about the mentees' perspective to assess the implemented mentoring process. This is a comprehensive survey which has been provided at the end of each three semesters from SS 2020 till SS 2021. A part of the survey design included the questionnaire for assessing motivation triggered through the use of ARS among the students.

The part of the survey used for this study is designed by adapting the Academic Motivation Scale (AMS) (college version) [36]. Based on SDT, the original scale is divided into seven subscales, presenting three subscales of intrinsic motivation, three subscales of extrinsic motivation, and one subscale of amotivation. The adapted version of the AMS for this study, contains six subscales' items which are three subscales of Intrinsic Motivation, two subscales of Extrinsic Motivation and one subscale of Amotivation. As the comprehensive survey is quite extensive and long, eight items out of 27 original items have been adapted from the six subscales for the purpose to assess the change in motivation by the mentoring process of ARS. So, the eight items are curated and reworded from the provided six subscales. These eight items have been selected and reworded by ensuring the face validity by a small group of mentees presenting the population and the content validity by the mentor as an expert. The Cronbach's Alpha (α) is 0.7 for the adapted motivation scale. Hence, adapted motivation scale have been presented deducing the six subscales into

three subscales by labeling them as the subscale of Intrinsic Motivation (ARS_IM), the subscale of Extrinsic Motivation (ARS_EM) and the last subscale which contains only one item having the construct of Amotivation (ARS_AM). The response format is also modified from the original scale from seven point likert scale to five point likert scale on the basis of level of agreement to match with the comprehensive survey's response format. Along with these eight items, this part of the survey has in total 10 item for assessing the mentoring by ARS. The other two items ask about total usage and usage frequency of the the offered four ARS in the lecture.

2) Data Collection and Sample: The data collection of this study has been conducted using the online comprehensive survey questionnaire. This survey is distributed via LimeSurvey, the online survey tool among all the registered students of the testbed course. The data collection period is one month at the end of each semester before the designated deadline for the final assignment submission. Students are invited to participate in the survey voluntarily via email and reminded atleast once per week to fill up survey via email reminder. Moreover, the usage data from the log file of the LMS and the final score of the course have been used to generate the findings of this study. To use the personal data, students have been asked to accept the particular privacy policy. In three consecutive semesters from SS 2020 to SS 2021, 84 students in total participated in the survey. Among them 57% are male students and 41.7% are female students and 1.2% is diverse from the reported sample. The current semester they are enrolled in range from 1 to 6 and age range is between 22 to 35 years. The most particular characteristic of the sample is that the students belong to completely international group having the nationality of India, Pakistan, Bangladesh, China, Turkey, Russia, Iran, Ghana, Syria, Colombia, Egypt, USA and Germany.

3) Data Analysis: Data analysis of the exported survey data includes cleaning and preparing the dataset by excluding the missing data from the incomplete responses. Afterward, the sample characteristics are determined from the demographic data by running descriptive statistics. Following this, the binary responses of the usage data and the frequency data are coded for quantification. The five point Likert Scale response format is coded with Strongly Agree as "1", Agree as "2", Neither Agree Nor Disagree as "3", Disagree as "4" and Strongly Disagree as "5". This is conducted for all the eight items of the adapted version of AMS. For the subscales of IM and EM, the data is treated as interval data [37] and so measures of central tendency and variability are conducted to analyze the data. As the subscale of AM has only one item, it is treated as Likert-type question to analyze the descriptive statistics as ordinal data [37] without transforming it to reverse-coded item.

For the contexual analysis, students' ARS usage data and students' summative assessment data from the five semester starting from SS 2019 to SS 2021 have been analyzed. For this purpose, the usage data have been exported from the LMS for every semester. In addition, the students' evaluation forms, filled out by the examiners, were used as data basis. The data analysis process has been done by two perspectives: dropout rate and, ARS grading influence in dependency of ARS usage frequency.

The first perspective, dropout rate, was chosen as an indicator to measure motivation, since it can be assumed that motivated students drop out less (cf. [38]). In the seminar are three time duration for dropping the course. The first time duration is between start of the course and the topic selection, since one reason for dropping the course is the not received desired topic, measured by a course registration but no topic selection. Following this reasoning, the 2nd point in time is during the self study period on the topic, leading to a missing performance at the presentation date accompanied by a missing evaluation. Subsequently, the third time period is after the presentation phase until the report submission deadline, since another reason for dropping the course is an unsatisfactory performance at the presentation or problems during the writing phase. In this case no report is submitted until the given deadline, leading to a missing evaluation of the report.

The analysis of the ARS grading influence in dependency of ARS usage frequency represents the second perspective. Therefore the course participants have been divided into three groups representing the usage frequency. The first group ARS_{none} represents the students without ARS usage, while the second group ARS_{M1} contains all students with a minimum of one ARS participation. As last group ARS_{ALL}, a subset of ARS_{M1}, is used containing all participants participating in all four ARS tests. As a first step, the mean results of the respective groups per semester are examined providing a first indication of the influence of the usage frequency. To ensure the significance of the mean values, an ANOVA Analysis is conducted. To ensure the necessary preconditions for ANOVA analysis, the respective data are checked for normal distribution using D'Agostino's K^2 test and the Shapiro-Wilk test. For the data that do not follow the normal distribution, a two-way T-test (Welch's t-test) is used to determine the significance. In consequence the significance between the means of the groups ARS_{ALL} and ARS_{M1} compared to ARS_{none} are used as indicators for the motivation increasing, reasoned by the factors of outcome expectencies and self-efficacy of Social Cognitive theory [28].

IV. Results

A. Survey Results

According to the survey response 56 students have used at least 1 ARS, and 13% used all the ARS offered in SS 2020 and WS 2021. The mean value is on average 2.4 which is skewed towards the point of agreement in intrinsic motivation (ARS_IM) and the mean value for the extrinsic motivation scale (ARS_EM) is higher in every three semesters than the ARS_IM (cf. Table I). But the mean value is also in between the range of agree to neither agree nor disagreement. The lower standard deviations represent that the responses are spread close to the mean.

TABLE I
MEANS (AND STANDARD DEVIATIONS) FOR THE TWO ADAPTED SUBSCALES OF AMS IN THE CONSECUTIVE THREE SEMESTERS.

Subscales	SS 2020	WS 2020/21	SS 2021
ARS_IM	2.70 (1.00)	2.42 (0.74)	2.31 (0.63)
ARS_EM	2.98 (1.07)	2.73 (0.96)	2.63 (0.96)

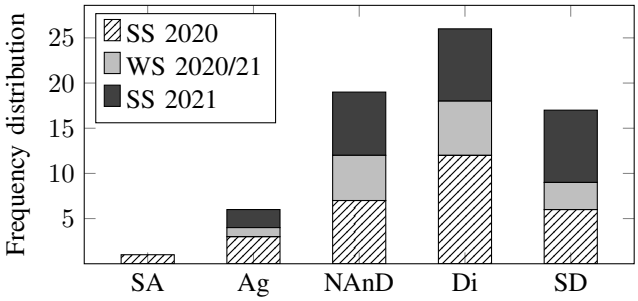

Fig. 2. Frequency distribution of the likert item on Amotivation over the three semesters (Strongly Agree (SA), Agree (Ag), Neither Agree nor Disagree (NAnD), Disagree (Di), Strongly Disagree (SD)).

On the contrary, the mode is 4 for all the three semesters which represents exactly the point of "Disagree" on the agreement scale for the Likert question result on amotivation. The frequency distribution (cf. Fig 2) states the frequency rate is higher on the disagreement point than the agreement point. About 28% of the respondents students are undecided in all the three semesters if their motivation to learn has decreased due to using ARS.

B. Assessment Data Analysis Results

The assessment data analysis bases on the grouping of the course participants into three previous introduced groups ARS_{none}, ARS_{M1} and ARS_{ALL}. The resulting group sizes are shown in Table II considering all registered curse participants. Thereby SS 2019 is the reference semester before ARS implementation. Considering the remaining semesters the amount of participants without ARS usage results between 47.4% and 58.11%, except SS 2020 with 34.12%. In consequence the amount of participants in group ARS_{M1} varies between 41.89% and 52.6% and for SS 2020 in 65.88% Group ARS_{ALL} varies between 13.51% and 30.59% representing approximately 45% of group ARS_{M1}.

The results of the assessment data analysis are presented by semester. As first perspective the dropout rate has been

TABLE II
RESULTING GROUP SIZE FOR ARS_{none}, ARS_{M1} AND ARS_{ALL}, CONTAINING ALL REGISTERED PARTICIPANTS.

Semester	Students	ARS_{none}	ARS_{M1}	ARS_{ALL}
SS 2019	94	94	0	0
WS 2019/20	70	35	35	19
SS 2020	85	29	56	26
WS 2020/21	74	43	31	10
SS 2021	76	36	40	18

TABLE III
DROPOUT RATE [%] BY SEMESTER AND TIME PERIOD T_1, T_2, T_3 FOR ALL COURSE PARTICIPANTS.

Time	**SS 2019**	**WS 2019/20**	**SS 2020**	**WS 2020/21**	**SS 2021**
T_1	5.32	10.00	3.53	14.86	14.47
T_2	20.21	27.14	3.53	28.38	25.00
T_3	26.6	32.86	21.18	28.38	25.00
	Dropout Rate Difference				
$T_2 - T_1$	14.89	17.14	0.00	13.52	10.53
$T_3 - T_1$	21.28	22.86	17.65	13.52	10.53

analyzed. The results are shown in Table III, comparing the dropout rate over all course participants. Three time periods have been considered, first T_1 from semester begin until topic selection, second T_2 from semester begin to presentation date and the last period T_3 from semester begin to final report submission.

By comparing the total dropout rate over the semesters of all participants big variation can be observed. However, the dropout rate in time period T_1 is not influenced by the ARS usage since the topic registration happens at the beginning of the semester, before the first ARS test has been conducted. Due to this reason, the difference between the dropout rate of T_2 to T_1 and T_3 to T_1 are analyzed. Both differences show a lower dropout rate compared to the reference semester (SS 2019) beginning with SS 2020. In WS 2019/20 a minor increasing of the dropout rate can be observed. One noted reason is the fact that the new system was offered for the first time in this form, resulting in an overwhelming situation for the students. Additionally the corona pandemic has been started in this semester, leading to being overwhelmed with the situation accompanied by a minimizing interest in the course. Furthermore, the dropout difference between T_3 and T_1 is constantly decreasing from WS 2019/20 to SS 2021. A comparable trend is shown for the difference between T_2 and T_1 starting from WS 2019/20 to SS 2021, except SS 2020 where no further student dropped out between topic selection and presentation appointment.

As second perspective the influence of the ARS usage on the final grading has been analyzed. Therefore the mean grading has been calculated for group ARS_{none}, ARS_{M1} and ARS_{ALL} for each semester. The results are shown in Figure 3. It can be observed, that the mean grading for group ARS_{none} is almost at the same level over all semesters, except SS 2020. This has to be reasoned by the corona pandemic, since this was the first semester where the lecture style has been changed form present lectures to full digital lectures. Due to this reason the students needed to adapt to the new learning and teaching situation leading to excessive demands and thus to grade reduction. Even though the mean grade has been reduced due to the teaching style changes, the mean grade of the groups ARS_{M1} and ARS_{ALL} result in a similar level as it was the mean before the pandemic. However, over all semesters the groups ARS_{M1} and ARS_{ALL}

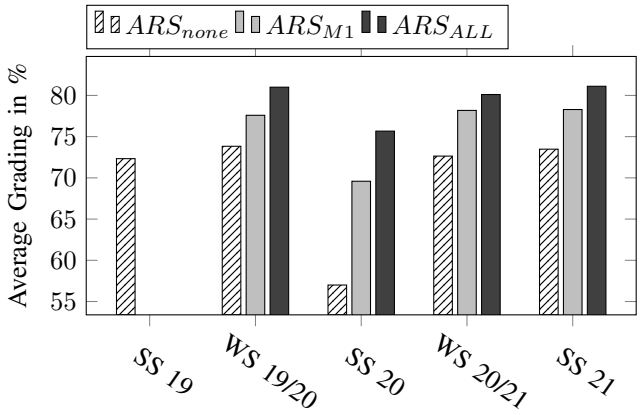

Fig. 3. Average grading results for presentation, report and final grading depending on subgroup.

resulting in an higher mean grading compared to the groups ARS_{none}. Furthermore, in all semesters the mean grading of group ARS_{ALL} is higher compared to group ARS_{M1}. In consequence, over all observed semester, except SS 2020, the mean grading of group ARS_{M1} and ARS_{ALL} is higher than the reference semester SS 2019. Additionally, by comparing the mean grading of group ARS_{ALL} over all semester, all semesters except SS 2020 resulting in an average grading between 79.9% and 81.1%. This results are approximately 7.4% higher compared to the mean grading results of the corresponding ARS_{none} groups. In SS 2020 the difference increases to 18.67%.

However, considering the mean values alone is unsufficient, since their differences could be within the statistical dispersion. The one way analysis of variance (one-way ANOVA) is used to examine the equality of the mean values. The application of ANOVA requires the gaussian distribution of the statistical variables leading to the necessity to test the groups for gaussian distribution before. For gaussian distribution testing the D'Agostino's K^2 test and the Shapiro-Wilk test are used. The test resulting p values are shown in Table IV. For the statistical analysis, only the participants with a final grading have been considered leading to a changing of student count compared to Table II. In both tests a p value higher than 0.05 is considered as proof of a gaussian distribution.

Accordingly, almost all groups showing a gaussian distribution for almost all semesters. One exception is SS 2020, where no gaussian distribution could be proven for any group with both conducted tests. Furthermore, in WS 2020/21 D'Agostino's K^2 test fails for group ARS_{none} while the Shapiro-Wilk test results in a gaussian distibution prove. However, since the Shapiro-Wilk p-value is with 7.8% close to the 5% threshold the group ARS_{none} is considered as none gaussian as well. In consequence for all groups in SS 2020 and WS 2020/21 a t-test is used to determine the equality of the mean values instead of the one-way ANOVA. For ANOVA and t-test result analysis the mean grading results of group ARS_{none} is compared to the mean values of ARS_{M1} and ARS_{ALL}. A comparison of the means between ARS_{M1} and ARS_{ALL} is not possible, since ARS_{ALL} is a subset of ARS_{M1}.

Examining the ANOVA results shown in Table IV, it is evident, that in WS 2019/20 the equality of the mean values for both test combinations is proven. A detailed examination of the results shows that the p value of 7.7% is close to the threshold value of 5% for the mean value comparison of ARS_{none} and ARS_{ALL}. Due to this reason a t-test has been conducted for this specific combination, confirming the ANOVA results, since again a p value of 8.2% is achieved by the t-test which is again close to the threshold value of 5%. Again, one reason could be represented the beginning corona pandemic, following the same argumentation for the dropout rate. Due to the overwhelmed situation, the student focus has been changed in the middle of the semester. This especially influenced the report writing leading to a bias of the grading results and subsequently leading to the failing of the ANOVA. Furthermore this semester represents the first prototypical implementation of the ARS in the lecture leading to a new learning situation.

In SS 2020 no gaussian distribution have been proven, therefore the t-test has been conducted resulting in a rejection of the mean value equality for both combination. On the contrary the t-test results for both test combination in WS 2020/21 proving the equality of the mean values. It must be noted that the number of students in the group ARS_{ALL} is very small with nine participants only. in SS 2021 the equality of the mean values of ARS_{none} and ARS_{ALL} is rejected, while the equality of the mean values of ARS_{none} and ARS_{M1} has been proven.

V. Discussion

This empirical study is aimed to observe if the embedment of ARS as a mentoring tool can impact the student's learning motivation in a structured mentoring process in a formalized setting at the university. This exploration of motivation in the mentoring process is conducted based on the concept of SDT by means of intrinsic motivation, extrinsic motivation and amotivation. The theoretical framework has been sufficed by following the motivational concept of Social Cognitive Theory and the structured mentoring model of Single et.al. [10] with the goal of attaining self-regulation among the mentees. The described mentoring process utilizes an ARS as a mentoring tool based on the didactical approach of ZPD. The findings of the online survey on the adapted version of AMS are clearly distinguishable by motivation and amotivation. It represents that the mean value of both the intrinsic motivation subscale and extrinsic motivation subscale are decreasing over the period of three semesters indicating the higher motivation of the students with the use of ARS. It could be reasoned by the updated implementation techniques of this blended mentoring technology [35] over the semesters by the mentor. The variability (SD) also tends to be lower than 1 from SS 2020 to SS 2021 which proves most of the participants have opined towards the point of agreement in each semester that indicates an increase in their intrinsic and extrinsic motivation. Moreover, the intrinsic mean value is consistently lower than

TABLE IV
STATISTIC ANALYSIS RESULTS FOR GROUP COMPARISON BETWEEN ARS_{none} AND ARS_{M1} JUST AS ARS_{ALL} SPECIFIED BY G_1 AND G_2 BY SEMESTER WITHOUT DROPOUTS (N_{G_X} REPRESENTS AMOUNT OF STUDENTS IN GROUP X).

	Groups		Student Count		D'Agostino's		Shapiro-Wilk		ANOVA G_1 & G_2		t-test G_1 & G_2	
Semester	G_1	G_2	N_{G_1}	N_{G_2}	p_{G_1}	p_{G_2}	p_{G_1}	p_{G_2}	F	p	t	p
WS 2019/20	None	ALL	18	16	0.3571	0.3205	0.1386	0.1943	3.3398	0.0770	-1.8019	0.0822
WS 2019/20	None	Min1	18	29	0.3571	0.4118	0.1386	0.4105	1.1061	0.2986	-	-
SS 2020	None	ALL	22	26	0.0395	0.0007	0.0095	0.0160	-	-	-2.2910	0.0271
SS 2020	None	Min1	22	48	0.0395	0.0001	0.0095	0.0010	-	-	-2.8908	0.0065
WS 2020/21	None	ALL	25	9	0.0347	0.5454	0.0783	0.3699	-	-	-1.6548	0.1179
WS 2020/21	None	Min1	25	28	0.0347	0.2679	0.0783	0.3466	-	-	-1.5829	0.1197
SS 2021	None	ALL	22	14	0.4737	0.3330	0.4601	0.1057	4.2064	0.0480	-	-
SS 2021	None	Min1	22	35	0.4737	0.3250	0.4601	0.1881	2.5013	0.1195	-	-

the extrinsic mean value which refers that the mentoring facilitation provided with ARS has activated comparatively higher intrinsic motivation among the international group of university students. Students received positive encouragement and constructive feedback on their performance in ARS, which increased intrinsic motivation and goes along with Deci's argument of SDT [23]. Along with these findings, the amotivation result show that majority of the student denied that they got demotivated by getting the mentoring support of ARS.

Furthermore, the assessment data analysis have been visualized a dropout rate reduction in these semesters than the previous semesters. This is supporting the findings of the escalated intrinsic motivation explaining the constant decrease of drop out rate from WS 2019/20 to SS 2021. This shows by the training and feedback support of ARS, the students have felt more competent, which is one of the key needs for personal growth and in building the sense of self-determination [23]. This rationale indicates that the students are involved in goal-directed cognitive activities that instigate, modify, and sustain their motivation to stay in the learning curve of self-regulated learning [6]. The mentoring process of ARS included activities as attending to instruction, processing and integrating knowledge, and rehearsing information to be remembered, as well as beliefs concerning capabilities for learning and the anticipated outcomes of learning [30] which are the process of student's cognition.

Corroborating these assumptions, the significant positive influence of the ARS on the final grading could be proven for the group ARS_{ALL} in SS 2020, SS 2021 and for group ARS_{M1} in SS 2020 by grading analysis. Taking into consideration, the close mean equality in WS 2019/20, only in WS 2020/21 has no significance for group ARS_{ALL}. This can be reasoned by the participation count in this group, since only nine students have participated in all ARS tests in WS 2020/21. Furthermore, a compensation effect of the teaching style change reasoned by the beginning corona pandemic in SS 2020 is observed. In SS 2020 a mean grading reduction appeared, but the results of ARS_{M1} and ARS_{ALL} results at the level of the reference semester of SS 2019 proven by t-test results. This is confirming the result of variances in grading with the decrease in drop out rate and the increase in motivation to learn.

VI. CONCLUSION AND FUTURE WORK

A structured process-oriented mentoring approach would ideally promote understanding of and emphasis on self-regulated learning and would motivate the mentees to sustain goal-oriented behaviour [9]. In this conclusive study, the analysis of the survey data from every three semesters incorporating with ARS usage data and student achievement scores makes it prominent that the structured mentoring process is successfully implemented as planned. The mentoring functions of ARS are successfully executed in the planning phase, program structure phase, and in assessment phase of the structured mentoring process. This claim has been proven by the indication of the rise of students' learning motivation supported by SDT. Additionally, the specific indication of the type of motivation that is intrinsic motivation elevation by including ARS in the mentoring process has made decisive guidance for the mentioned testbed as well as for similar mentoring settings to use such training facility of digital formative assessment. The findings are supported by a reduction of the dropout rate as well as a part-wise improvements of the final grading. Substantially, the executed mentoring process assessment with formative and summative assessment data and survey data has demonstrated the feasibility to plan the next iteration.

In spite of evidencing the motivational growth, the instrument for data collection needs to be improved further by elaborated testing of item analysis. It will then support confirming the generalizability of the findings. Additionally, in the assessment data analysis the participants with direct ARS interaction have been analyzed only, representing just a subset of the students in the lecture. For this reason, side effects for students who did not participate directly in the ARS tests but followed the discussion in the lecture are conceivable. Moreover, another limitation of this study is the sample size. In future studies, it is recommended to analyze the data with a larger sample. Furthermore, this structured mentoring process needs to be tested based on the mandatory psychosocial learning constructs to establish it in the higher education system. Further work needs to address the reduction of effort in process assessment in order to automate the collection and evaluation of the motivation indicators.

REFERENCES

[1] K. Shabani, "Dynamic assessment of l2 learners' reading comprehension processes: A vygotskian perspective," *Procedia-Social and Behavioral Sciences*, vol. 32, pp. 321–328, 2012.

[2] L. A. Daloz, *Mentor: Guiding the journey of adult learners (with new foreword, introduction, and afterword)*. John Wiley & Sons, 2012.

[3] L. L. Bierema and S. B. Merriam, "E-mentoring: Using computer mediated communication to enhance the mentoring process," *Innovative higher education*, vol. 26, no. 3, pp. 211–227, 2002.

[4] L. R. Gaskill, "A conceptual framework for the development, implementation, and evaluation of formal mentoring programs," *Journal of Career Development*, vol. 20, no. 2, pp. 147–160, 1993.

[5] B. J. Zimmerman, "Developing self-fulfilling cycles of academic regulation: an analysis of exemplary instructional models." 1998.

[6] ——, "Becoming a self-regulated learner: An overview," *Theory into practice*, vol. 41, no. 2, pp. 64–70, 2002.

[7] T. Sitzmann and K. Ely, "A meta-analysis of self-regulated learning in work-related training and educational attainment: what we know and where we need to go." *Psychological bulletin*, vol. 137, no. 3, p. 421, 2011.

[8] M. K. Johnson, L. Symes, L. Bernard, M. J. Landson, and T. L. Carroll, "Mentoring disadvantaged nursing students through technical writing workshops," *Nurse educator*, vol. 32, no. 4, pp. 168–172, 2007.

[9] D. H. Schunk and C. A. Mullen, "Toward a conceptual model of mentoring research: Integration with self-regulated learning," *Educational Psychology Review*, vol. 25, no. 3, pp. 361–389, 2013.

[10] P. B. Single and R. M. Single, "E-mentoring for social equity: review of research to inform program development," *Mentoring & Tutoring: Partnership in Learning*, vol. 13, no. 2, pp. 301–320, 2005.

[11] C. W. Lewis, "International telementor program (itp) report: Evaluation results from teacher surveys, may 2000–march 2002," *Retrieved April*, vol. 17, p. 2002, 2002.

[12] E. A. Ensher, S. C. de Janasz, and C. Heun, "E-mentoring: virtual relationships and real benefits," in *Academy of Management Annual Meeting*, 2004.

[13] D. K. O'Neil and L. M. Gomez, "Online mentors: Experimenting in science class." *Educational Leadership*, vol. 54, no. 3, pp. 39–42, 1996.

[14] P. B. Single and C. B. Muller, "When email and mentoring unite: The implementation of," *Creating mentoring and coaching programs: Twelve case studies from the real world of training*, p. 107, 2001.

[15] J. Norcini and V. Burch, "Workplace-based assessment as an educational tool: Amee guide no. 31," *Medical teacher*, vol. 29, no. 9-10, pp. 855–871, 2007.

[16] K. M. Cauley and J. H. McMillan, "Formative assessment techniques to support student motivation and achievement," *The clearing house: A journal of educational strategies, issues and ideas*, vol. 83, no. 1, pp. 1–6, 2010.

[17] J. M. Spector, D. Ifenthaler, D. Sampson, J. L. Yang, E. Mukama, A. Warusavitarana, K. L. Dona, K. Eichhorn, A. Fluck, R. Huang *et al.*, "Technology enhanced formative assessment for 21st century learning," 2016.

[18] J. V. Wertsch, *Culture, communication, and cognition: Vygotskian perspectives*. CUP Archive, 1986.

[19] L. S. Vygotsky and M. Cole, *Mind in society: Development of higher psychological processes*. Harvard university press, 1978.

[20] S. T. Haines, "The mentor-protégé relationship," *American Journal of Pharmaceutical Education*, vol. 67, no. 1/4, p. 458, 2003.

[21] K. E. Kram, "Phases of the mentor relationship," *Academy of Management journal*, vol. 26, no. 4, pp. 608–625, 1983.

[22] H. Tinoco-Giraldo, E. M. Torrecilla Sanchez, and F. J. García-Peñalvo, "E-mentoring in higher education: a structured literature review and implications for future research," *Sustainability*, vol. 12, no. 11, p. 4344, 2020.

[23] E. L. Deci and R. M. Ryan, "Self-determination theory." 2012.

[24] J. Reeve *et al.*, "Self-determination theory applied to educational settings," *Handbook of self-determination research*, vol. 2, pp. 183–204, 2002.

[25] E. L. Deci and R. M. Ryan, "Self-determination theory: A macrotheory of human motivation, development, and health." *Canadian psychology/Psychologie canadienne*, vol. 49, no. 3, p. 182, 2008.

[26] R. M. Ryan and E. L. Deci, "Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions," *Contemporary educational psychology*, vol. 61, p. 101860, 2020.

[27] S. Janssen, M. van Vuuren, and M. D. de Jong, "Identifying support functions in developmental relationships: A self-determination perspective," *Journal of vocational behavior*, vol. 82, no. 1, pp. 20–29, 2013.

[28] A. Bandura, "Social cognitive theory of self-regulation," *Organizational behavior and human decision processes*, vol. 50, no. 2, pp. 248–287, 1991.

[29] M. Boekaerts, M. Zeidner, and P. R. Pintrich, *Handbook of self-regulation*. Elsevier, 1999.

[30] D. H. Schunk, "Social cognitive theory and self-regulated learning," in *Self-regulated learning and academic achievement*. Springer, 1989, pp. 83–110.

[31] P. H. Henning, "Everyday cognition and situated learning," *Handbook of research on educational communications and technology: A project of the association for educational communications and technology*, pp. 829–861, 2004.

[32] S. Kadzomba, "An evaluation of the impact of a mentoring programme in two soweto based schools," Ph.D. dissertation, 2015.

[33] C. Y. Young and J. V. Wright, "Mentoring: The components for success," *Journal of Instructional Psychology*, vol. 28, no. 3, pp. 202–202, 2001.

[34] Employment and Training Administration United States Department of Labor, "Information technology competency model," September 2012. [Online]. Available: www.careeronestop.org/competencymodel/info_documents/it-industry.pdf

[35] U. U. Shegupta, R. Schmidt, M. Springwald, and W. Hardt, "Audience response system-an inclusion of blended mentoring technology in computer engineering education," in *2020 IEEE Frontiers in Education Conference (FIE)*. IEEE, 2020, pp. 1–5.

[36] R. J. Vallerand, L. G. Pelletier, M. R. Blais, N. M. Brière, C. B. Senécal, and É. F. Vallières, "Academic motivation scale (ams-c 28), college (cegep) version," *Educational and Psychological Measurement*, vol. 52, no. 53, pp. 1992–1993, 1993.

[37] D. Bertram, "Likert scales," *Retrieved November*, vol. 2, no. 10, 2007.

[38] A. Tayebi, J. Gómez, and C. Delgado, "Analysis on the lack of motivation and dropout in engineering students in spain," *IEEE Access*, vol. 9, pp. 66 253–66 265, 2021.