An Education Model for Game Development by A Swedish-Japanese Industry-Academia Alliance

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***Abstract*—This paper presents and evaluates a new educational tool and a model for learning theory and practice of game development, by involving geographically separated and culturally different industrial and academic organizations. We propose a TRIAD education model, which is as an extension to the conventional project-based learning, by uniting industry staff, faculty members, and students in an online discussion space. This model is a two-phase cyclic model where in Phase-1) industry members and academic staff discuss the progress of PBL transparently, showing the cross-cultural gaps and advising how to solve them, and in Phase-2) students make progress on the projects. Additionally, the TRIAD model adopts asynchronous text messaging as a core communication method, which is suitable for a multi-timezone situation, as well as exchanges of self-reviews from students and feedback from instructors. The online space not only facilitates interns in overcoming the hurdles represented by the gaps between the industry and academia, but it also visualizes the students' implicit educational progress by periodically analyzing all stored data by applying quantitative text analysis methods. This paper shows the result of an empirical study by utilizing this TRIAD model and analytics tool conducted at a large-scale Japanese game company with over 2,000 employees focusing on two students from the division of game development at a university in Sweden. We applied a quantitative text analysis tool for this model during an on-going internship program to clarify how students change their thoughts and behaviors by acquiring cross-cultural professionalism in the game industry. In addition, the result indicates that this TRIAD model is resilient, even under the COVID-19 epidemic situation due to its text-based approach.**

***Index Terms*—game development education, industry-academia alliance, project-based learning, distance education, natural language processing, evidence-based education**

I. Introduction

The widespread proliferation of game engines has significantly lowered the hurdles for creating games, by allowing individual game developers to create a single game by limiting costs and time [1] [2]. This shift to general-purpose game engines not only made know-how of game development reusable among different companies and organizations but also allowed a wide range of people to join game creation [3]. Additionally, modern digital distribution platforms, such as the Apple App Store, Google Play, and Steam, have opened up the gaming market in terms of accessibility for developers and users alike [4]. Concurrently with this democratization of game development, academic avenues for game research, such as DiGRA, IEEE CoG, and ACM CHI PLAY, have become visible in international academic communities [5].

However, the gap between the game industry and academia remains open [6] [7], even though previous research has stated the importance of collaboration between industry and academia to educate students for future game development [1] [8]. For example, there is a difference in the types of skills needed, as the industry requires more emphasis on programming than academic institutions, which causes friction between the two sectors [9]. To bridge this gap in game research and education, researchers sought to develop academic programs, events, and tools for game development by involving the industry [10] [11] [12] [13] [14]. Additionally, the current globalization of the games market requires close collaboration of people who have different origins and cultures [15]. It is desired to develop a new collaboration model that fills both, gaps between the game industry and academia, and the gap that implicitly or explicitly exists in the global environments.

Therefore, this paper presents and evaluates a novel model and analytics tool for global industry–academia collaborative game education (Fig.1). In this model, students learn theory and practice on game development by involving geographically distanced and culturally different industrial and academic organizations. This paper proposes *a TRIAD education model*, which incorporates three actors: (1) industry staff of a game company, (2) faculty members of a university, and (3) students studying game development. The model aims to foster the skills of students studying game development by teaching them what is required when working at game companies as well as practicing theories and skills acquired at university.

The TRIAD model is applied to the conventional project-based learning (PBL) as a pedagogical extension, proceeding in a two-phase cycle, where in Phase-1 industry members and academic staff discuss the progress of PBL transparently, pinpointing cross-cultural gaps and advising how to solve them, and in Phase-2 students make progress on the projects. In addition, the TRIAD model adopts asynchronous text messaging as a core communication method, which is suitable for a multi-time zone situation, as well as exchanges of self-reviews from students and feedback from instructors. The online space not only facilitates interns in overcoming

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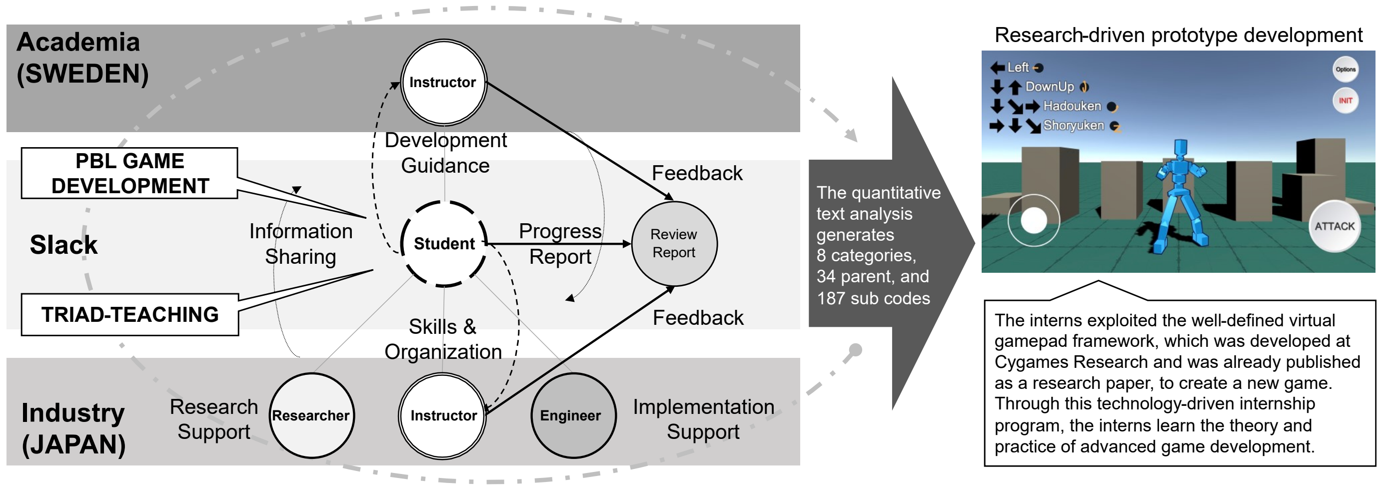

Fig. 1. The TRIAD education model incorporates industry staff, faculty members of a university and students learning game development. Students submitted self-review reports and instructors posted feedback in the online discussion space. Researchers quantitatively analyzed texts to measure the impact of the TRIAD model.

the hurdles represented by the gaps between the industry and academia, but it also enables to visualize the students' implicit educational progress by periodically analyzing all stored data through quantitative text analysis methods.

We conducted an empirical study at a large-scale Japanese game company with over 2,000 employees focusing on two students from the division of game development at a university in Sweden in order to investigate this TRIAD model with a quantitative text analysis tool, during an on-going internship program. The study aimed to clarify how students change their thoughts and behaviors by acquiring cross-cultural professionalism in the game industry. We utilized Slack as an online discussion space to enable sharing messages and exchanging self-reviews and feedback between Japan and Sweden. We analyzed five weeks worth of text-based data stored in the Slack workspace, including ten self-review reports submitted by the students and ten feedback comments given from the instructors, through a quantitative inductive coding analysis. This resulted into generating 741 segments sorted into eight categories, 34 parent codes and 187 sub codes.

The result of the analysis clarifies that the Swedish students, assisted for guidance on game development by a faculty in Sweden throughout the internship, showed changes to their behavior by enhancing collaboration and communication with Japanese industry staff. As students initially showed anxiety and struggle when trying to conciliate the requirements of industry and academia, they gradually earned confidence in making self-decisions to overcome the hurdles of cross-cultural communication. In addition, this study indicates that the TRIAD model is also resilient in emergency situations due to its text-based approach. For example, it proved effective when responding to the COVID-19 pandemic. Further, this paper highlights the difficulties of organizing an industry-based internship, such as balancing academic requirements within industry restrictions as well as adjusting expectations to required skills and plans for the internship. It also contributes to discussing a new method for game education as well as to finding a solution to bridge the gaps between the gaming industry and research-oriented academia, with a focus on how to foster the next generation of game developers.

This research contributes to presenting a novel education method and a tool to measure the impact of this TRIAD model at game companies on the students' competence. This study shows how both industry and academia can educate students by collaborating with each other on a global level; moreover, it demonstrates how both institutions can analyze the students' changing skills and activity as well as their motivation.

II. Related Work

The learning approach of PBL-based courses have traditionally been shown to be effective among scholars. PBL is a teaching method in which students gain knowledge and skills through an investigative project by engaging with and responding to complex questions; as a result, students develop deep knowledge as well as critical thinking, collaboration, creativity, and communication skills [16]. The PBL framework includes two essential components of projects, which in turn require a problem that drives the activities; these result in a final artifact or product [17]. Other essential elements of PBL include a degree of student choice, incorporating feedback from instructors as facilitators and revision [18]. Formative assessment should be a cyclical activity that occurs several times in a PBL [19]. As feedback is central to formative assessment [20], self-assessment enables students to evaluate their activities and identify their tasks [21]. Furthermore, current research has proved that communication technology can be used to support formative feedback in many different ways [22]. Based on the positive theories on integrating PBL in teaching, previous research has attempted to do the same with game development courses.

Such research has been conducted at several universities with the aim to involve students in industry-relevant practices while simultaneously learning necessary theory and earning skills. Researchers have discussed how the PBL method could be effective in game development courses [23], [24], [25], [26]. Moreover, a global collaborative attempt has been made for transferring the Western game education method to an Asian university for game development [27], noting that an interdisciplinary PBL course in game development can be successfully conducted in another culture.

In terms of industry–academia collaborative research on game studies, previous researchers have worked with the gaming industry to propose several types of methods for its education. For example, the gaming industry has been involved in courses as guest lecturers and evaluators for gaming competitions [10]. Developers at AAA companies provided insights to researchers in order to invent an educational tool for game development PBL-oriented classes [14]. Members of the gaming industry collaborated with academia to organize a Game Jam for university students to realize a PBL-style game design [13]. Furthermore, the industry has actively contributed to PBL-oriented projects by offering on-site environments for game development as well as giving advice on game development to students in their role of mentors [11], [12]. However, such collaborative game education utilizing the PBL is conducted on a national level, and a global industry–academia collaboration on a global level is yet to be seen. Furthermore, the applicability of PBL for game development internships at game companies, integrating directors and staff in the industry, faculty members in academia, and students has not been presented through a detailed and evidence-based analysis.

III. Method

To clarify the effectiveness of the TRIAD education model, we designed a research-driven game prototype curriculum in the internship program. Cygames, Inc., the game company, and the University of Skövde, a Swedish university, tightly collaborated to bring this internship curriculum to two Swedish students who stayed almost eight weeks in Japan. This curriculum aims to cultivate a fundamental skill to bring advanced research results to practical game development. We asked the interns to exploit a novel virtual gamepad framework, which was developed at Cygames Research and was already published as a research paper [28], to create a new game. Through this technology-driven internship program, the interns learn the theory and practice of advanced game development.

A. Assessment of the TRIAD Model

To analyze the outcomes of the TRIAD model, we created a template for self-review reports in order to document the activities and experience of the students participating in this study. We asked students to create and submit the report at the end of each week and instructors from both academia and industry to provide weekly feedback. We utilized Slack as a communication tool between Sweden and Japan. Students submitted the reports via Slack's workspace and instructors provided feedback. After the submissions from both students and instructors, we quantitatively and qualitatively analyzed the contents of the report, supported by the text analysis tool MAXQDA. We also observed the Slack workspace and conducted interviews during the internship with students and instructors to clarify the written context.

Previous research suggest that several technological tools can enhance the procedure of formative assessment [22]; this study sought an online communication tool that would enable to document such a procedure and create engagement (sharing & collaborating) between the students, researchers, and engineers in Japan and Sweden. Previous PBL-based game development education studies utilized ICT tools such as the task management systems of 4PM, and Edmodo [12]. For this game education program encompassing industry and academia, we decided to utilize Slack as a communication platform, as all information and documents could be stored and checked in real-time sequence from both countries at all times, remotely or on site. All members involved in this study from the industry and academia joined in the workspace and created relevant channels to share information. In this workspace, members created a channel to record the progress of the game development project; the students participating in the internship submitted self-review reports in the Slack channel consisting of the following questions for self-assessment: (1) activities/interactions regarding the research during the week; (2) topics discussed; (3) current problems and solutions; (4) the plan for the following week; (5) feedback from instructors. The instructors provided feedback as a response to this self-assessment in Slack from Japan and Sweden.

B. Tools for Analysis

This research paper presents the results of an ongoing internship program by analyzing data retrieved from a five-week investigation, involving two students from Sweden (Student A and B), one Japanese instructor from the industry (Industry Instructor), one Swedish instructor from a university in Sweden (Academia Instructor), and staff working in the industry, including four researchers, four engineers and two members of the administrative staff. We instructed the students to submit their report at the end of each week, as this enabled them to reflect upon their activities. After the submission, the instructors provided feedback online. During the five-week investigation, we analyzed ten self-review reports (8,048 words) from the students and ten feedback comments from the instructors (3,155 words) (Fig.2). Employing the feedback analysis procedure by Wingate [29], we analyzed reports to identify (1) the progress of the students during the internship and (2) how their progress could be linked to using the feedback provided by the instructors. By utilizing a grounded theory approach [30], the first step of the text analysis was the manual open coding of the self review reports and feedback. Text segments were sorted into categories by constant comparison. This process was supported by MAXQDA, which provided visualization and intuitive functions to sort codes (Fig.3). MAXQDA identified the interrelations of the coded segments from the reports and feedback by the code matrix

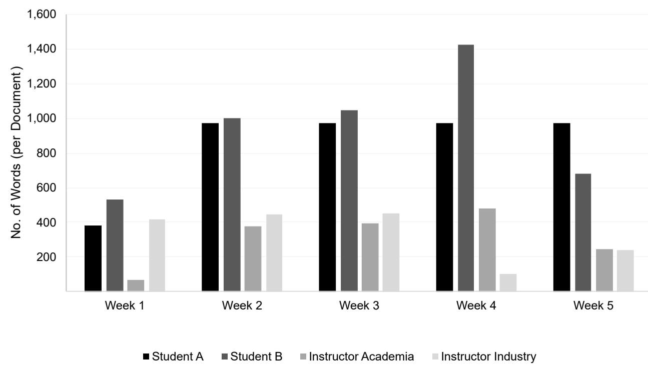

Fig. 2. We quantitatively analyzed texts submitted by students and instructors for five weeks. Student A and Student B reported their activities and experience as self-review reports at the end of each week, amounting to 8,048 words. Instructors in Industry and Academia posted feedback to the reports, amounting to 3,155 words.

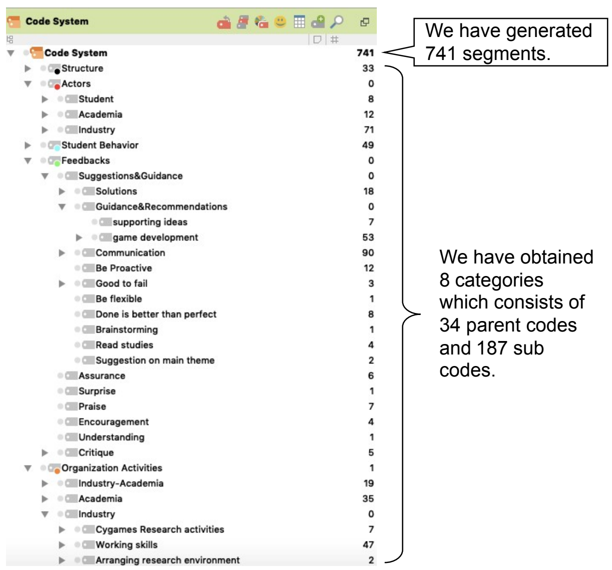

Fig. 3. MAXQDA displays the list of codes and numbers of coded segments in the system's interface. We sorted and organized the codes into categories through this visualization system.

browser tool, to see how the recommendations in the feedback appear on the students' activity reports. In addition to text analysis, we observed Slack's workspace. We named the documents in the following way: each document was assigned a code for its origin—SA for Student A, SB for Student B, I for Industry Instructor and A for Academia Instructor. Numbers followed after the code, describing the week the document was written in, resulting into file names such as SA1, SB2, I1, A1, etc. We conducted the coding based on discussions among researchers and by talking with the participants of this study. The results below show the types of activities and behaviors mentioned in the two students' self-review reports, the types of feedback given by the two instructors, as well as how the students reflected the feedback in the reports. This coding analysis limits the extent to identify the advantages and

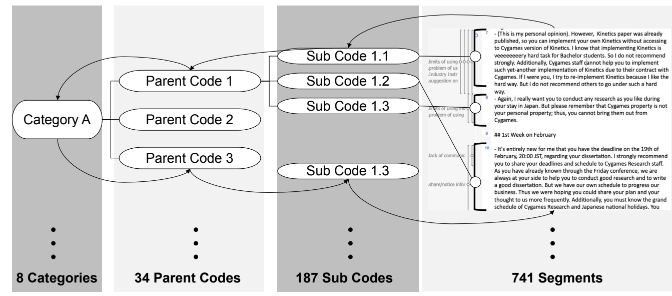

Fig. 4. The categorization of the generated codes proceeds from right to left. We coded the text data in three steps: 1) breaking down the text into 741 segments belonging to 187 sub codes, 2) sorting the sub codes into 34 parent codes and 3) into 8 core categories.

disadvantages of this program. On the other hand, the results of this analysis shows a basis for developing an assessment model for game education in the future.

IV. Results

We coded the documents in three steps: (1) open coding: breaking down text data into segments through the hermeneutic interpretation of the context and applying in-vivo codes—i.e., codes taken directly from the text. This resulted in a total of 187 sub codes; (2) axial coding: the coded segments are sorted into categories based on thematic similarities. This is a repetitive deductive phase and resulted in 34 parent codes; (3) selective coding: determining the core categories characterized by the relationship with axial categories, which resulted into eight core categories to evaluate the outcomes of the TRIAD model (Fig.4). MAXQDA supported the visualization of the codes and the code frequency counting process.

This study utilized the following eight categories:

- *Structure* includes codes of report structure;
- *Actors* include codes of mentioned members, such as students, instructors and and industry staff in the report;
- *Student Behavior* includes all codes related to students' general attitude and behavior during the internship;
- *Feedback* includes all codes related to concrete feedback from instructors and how the students reflected upon it;
- *Organization Activities* include codes related to mentions about activities in the industry or academia;
- *Project Activities* include all codes related to comments about project activities throughout the internship;
- *Slack* includes codes related to mentions about the utilization of the communication space;
- *Culture* includes all codes involving mentions about cultural similarity or difference.

The changes of the code frequency overtime are shown in Fig.5 to Fig.8. Fig.5 shows the types of project activities the students have engaged in throughout the PBL-style internship by incorporating the TRIAD model, while Fig.7 shows how their behavior changed during the same time frame. The types of feedback the students were given on their activities from the instructors in Japan and Sweden are shown in Fig.6; how the students reflected the given feedback in their activities is shown in Fig.8. The results of the text-based analysis show that the TRIAD model of proceeding the iterative cycle of students' self-reviews and earning constant feedback from the instructors in Japan and Sweden affects their progress on the game development project and their motivation for working in the game industry. The following section describes the detailed outcomes of the TRIAD model-based game development internship program by quantitatively clarifying how students overcame the problems between the industry and academia by earning feedback and interacting with the company staff in four steps: (1) facing confusion and problems between academia and the industry; (2) considering solutions by earning feedback and communication; (3) adapting to the environment, and (4) outcomes.

A. Facing Confusion and Problems

At the beginning of the internship from week 1 to week 3, students mentioned feeling "Nervous" or "Hectic" (coded 3 times; Fig.7) and they "Struggled between Industry-Academia" (coded 8 times; Fig.7) in the "Research Preparation" phase (coded 22 times; Fig.5), as they sought to combine the internship with an academic research project required for graduating university. As the research project began at an in-house research division of the game company, both students faced the problem of conducting academic research that would satisfy both the industry and academia. First, regarding the difficulty of writing a research proposal to fulfill the academic requirements and proceeding practical activities at the company, SA said, "It feels to me like we're walking a tightrope between writing good research and making a good artifact and evaluation," (SA2) even though they were expecting to "use our time at the company as much as possible and make use of the technologies" (SB2). They settled on the aim of the research being that of carrying out a game development project through a technique originally developed by the company, and followed advice from both industry and academia instructors. Then, they came across the unexpected difficulties of planning their resource and research methods, as the students noticed that they could not use said technology outside the company, which was, "a big blow to our current plans..." (SB2). At the same time, the students worked on their "Interview Preparation" with game developers (coded 36 times; Fig.5) to consider a suitable game genre for their project. However, they faced difficulties of "Expectation Difference" and communication (coded 1 time; Fig.7) between the Japanese industry and Swedish academia in this activity; it was mentioned that the research idea "became bigger than we wanted it too, possibly due to misunderstandings, miscommunication..." (SB4). The problems of communicating with the Japanese staff at the office was mentioned, especially during the preparation phase for research and interview, as students expressed hesitation and a lack of communication with the industry instructor and staff.

B. Earning Feedback and Communication

By facing the hurdles of conducting game development research as well as the difficulties of being in between industry and academia, solutions for overcoming the problems of research and communication were sought by the two students, acquiring and practicing feedback given from both instructors. Fig.6 shows how both instructors of industry and academia supported the students by emphasizing different types of comments on a balanced cycle. The academia instructor (A) in Sweden commented more on "Game Development" (34% of the overall comments from A; Fig.6), while the industry instructor (I) placed emphasis on advising more "Communication" with the staff on site (57% of the overall comments from I; Fig.6). The instructors recommended to not only establish more communication in the working environment, but also to "Be Proactive" (coded 4 times; Fig.6).

The effects of the advice were clearly shown in the students' activities. Fig.8 shows how the students reflected the feedback received throughout the internship. The frequency of the codes in the students' reports indicate that they both tried to reflect the recommendations received from both institutes in the weeks immediately following. As the students started to interact more with the "Japanese Staff" and "Engineers" from week 3 (coded 23 times; Fig.8), the planning and the "Creating of Game Prototype" proceeded in parallel (coded 14 times; Fig.8). The students began to communicate willingly by "Discussing" research ideas (coded 5 times; Fig.8) and "Earning Feedback" from the researchers and engineers in the company (coded 11 times; Fig.8). From week 4, in order to overcome the misunderstandings between the industry and academia, the students not only realized the necessity of communication, but also understood the importance of making "Self-Decisions" and "Conveying Clear Thoughts" to the staff, which is shown through a substantial increase of the code frequency (coded 12 times; Fig.7). Hereby, students have noticed the advantage of utilizing Slack by mentioning that "we should write a more frequent small concise report in a Slack message of what we have done, what we are doing and what we plan to do" (SB4). The students started to "Share and Report" their progress briefly in Slack (coded 5 times; Fig.8), as well as "Ask Help" from the staff through the communication space available (coded 9 times; Fig.8); this enabled the instructors and staff to acknowledge the procedure of project as well as to provide advice toward their future activities.

C. Adapting to the Environment

As the problems during the research preparation were solved and students started focusing on developing the game prototype from week 4, they gained independence and confidence in their activities by mentioning "Self-Praise" in their activities (coded 9 times; Fig.7). At the same time, they adapted to the "Communication" with staffs (coded 17 times; Fig.8) and the game development routine of creating a "Game Prototype" of a "Fighting Game" at the company (coded 14 times; Fig.8). In addition, the students started noticing the advantage of

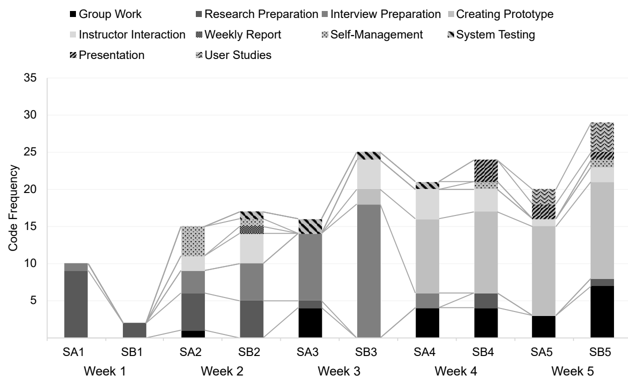

Fig. 5. Changes in Project Activities of Student A (SA) and Student B (SB) from Week 1 to Week 5: The interns faced confusion and problems between academia and the industry, and they solved those problems by earning feedback and observing how two different instructors have communicated.

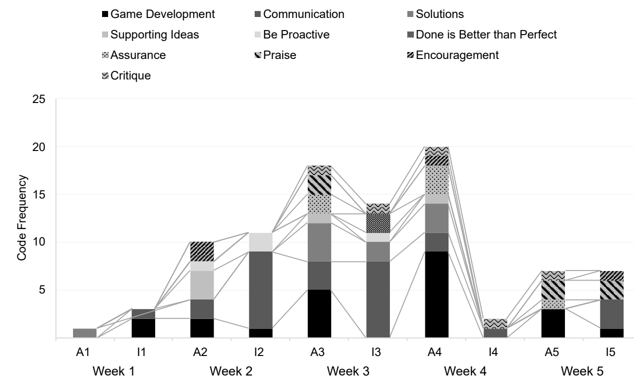

Fig. 6. Types of Feedback Given from Academia Instructor (A) and Industry Instructor (I) from Week 1 to Week 5: The Academia Instructor (A) focuses on the game development and Industry Instructor (I) focuses on the project management.

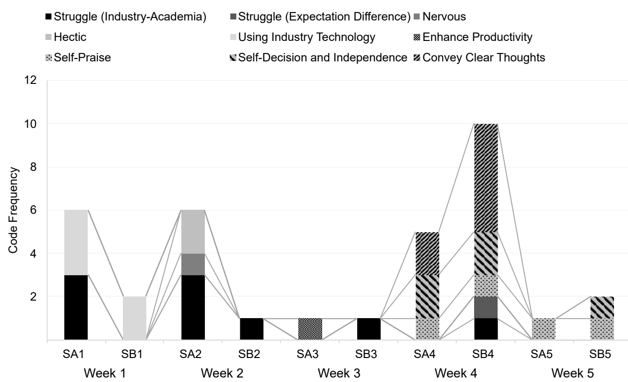

Fig. 7. Changes in Behavior of Student A (SA) and Student B (SB) from Week 1 to Week 5: They became more proactive and independent during the internship program.

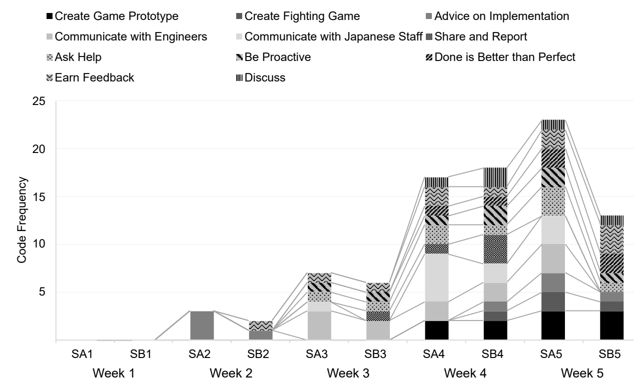

Fig. 8. Reflection of Given Feedback from Instructors in Student A (SA) and Student B (SB) from Week 1 to Week 5: The interns earned know-how and concepts in multiple aspects of game development through the internship.

"Group Work" activities (coded 19 times; Fig.5), as they began to mention discussing and deciding together, dividing and managing tasks with each other and trying to find and solve problems that appeared during the implementation phase of the industrial technique into the students' original game development. However, as the feedback from the instructors suddenly drops in week 5, the students stopped sharing initiative progress reports as they continued on their game production and preparation for the next user study; however, this led to further issues, confusion, and misunderstandings, as no one was aware of the problems and progress of the project.

D. Outcomes

Comparing Fig.6 and Fig.8, recommendations from the instructors to "Game Development" (25% of the given comments) and to communicate more with the "Japanese Staff" and "Engineers" (30% of the given comments) are also reflected in the students activity the following week. As the instructors gave advise on both activities from week 2 to week 4, the students mentioned that they had discussed their project plans and ideas with the "Japanese Staff" (coded 11 times; Fig.8), earned feedback, asked the "Engineers" for help (coded 12 times; Fig.8) in order to implement the technology in their dissertation, which linked to the continuous procedure for game prototype development. In week 5, the students had willingly submitted a video of the demo version of the game prototype in Slack to share their outcomes. Moreover, as students overcame the obstacles of communicating with industry staff and successfully earned consensus within the company regarding their research project after week 3, they gained self-confidence in expressing their "Decision" and "Independent" ideas from week 4 (coded 5 times; Fig.7).

The students also noticed the productivity advantages of "Group Work" from week 4 (coded 19 times; Fig.5), by discussing problems and solutions with partners and managing tasks together in order to complete the project in a limited amount of time. However, the relation between the decline of feedback from the industry instructor from week 4 and student behavior indicate that the students could keep working on creating games, but easily became unaware of the possibility of communication (codes related to communication decreasing to 6 times from 11 in week 5; Fig.8). This indicates that the major hurdle of this internship was to communicate with people of another culture and position, as well as to seek help from the Japanese staff in the TRIAD model. To overcome those drawbacks, the academic instructor and industry instructor discussed how to clarify the meaning of game development jargon in the cross-cultural environment. It is crucial to mention that this discussion was fully visible to the students in Slack. For example, the definitions of "developer", " designer", and "level-design" are different between Western and Japanese culture. The instructors clarified the meaning of such essential words in game development precisely through the daily discussion.

The text analysis also clarified the different roles of the industry staff and academia faculty in the TRIAD model. The academia instructor gives feedback on the contents of the dissertation project on "Game Development" and also "Supports Ideas" and provides "Solutions" (Fig.6). On the other hand, the instructor and other co-workers at the industry play different roles. Mentioned in "Communicating with Engineers" and "Japanese Staff" (Fig.8), the co-workers support the students' activity plans by sharing multiple discussions, giving advice to their dissertation such as "recommending to try several mobile games using virtual joysticks" (SA3), discussing the "problems of interview" (SB4) and whether to create a "First-Person Shooter or a fighting game" (SA4, SB4). The engineers helped overcome the game development difficulties the students faced, and "held sessions for using Unity" (SA4), "debugging and code writing" (SA4). The industry instructor contributes to deciding the execution of the students' activity, preparing the research environment and relevant human resource, such as "arranging an interview with directors" (I3) and "configuring technical issues" (I1) at the company in order to fit the academic requirements for the students' project. The industry instructor also taught students the difficulty of "Game Development" (Fig.6) by implementing industrial technology and necessary research and working skills, during the students' research preparation phase, such as "be proactive and discuss ideas with the people close to you" (SA3) with the importance of communication.

The online discussion space proved functional in delivering the cross-cultural communication and information with the members involved in the workspace, regardless of time, language and geographical differences. In addition, the space was utilized in several forms by exchanging messages and data in multi-media formats. In terms of the research project, the brief reports on the students' research activities enabled the staff to determine what kind of tasks or assistance the students required. As the students requested help, the staff were able to respond by flexibly offering knowledge or skills, regardless of the location, such as for installing necessary technology assets, translating Japanese documents into English. The space also became a platform where instructors discussed cultural differences, such as the difference of terminology regarding the roles in game development (e.g., game developer and designer), as well as working manners, such as absence and handling company assets. Furthermore, the space also allowed to share information for the students' travel and stay in a foreign country.

The TRIAD model, in particular, functioned as a method for arranging the continuation of research projects even during emergency situations. As the students were required to return to their home country toward the end of this study due to the COVID-19 pandemic, Slack enabled them to arrange the departure and further plans in a short amount of time by involving their academia instructor in Sweden. This indicates that the workspace enables members to continue working on the same data flexibly in the case of an emergency.

V. Discussion and Conclusion

We empirically investigated the procedure and outcomes of an ongoing industry–academia game development education program at a large scale Japanese game company with two students from Sweden. We designed an internship program with a TRIAD education model, which is as an extension to the conventional project-based learning (PBL), by uniting industry staff, faculty members, and students in an online discussion space. We analyzed how students change their thoughts and behaviors during the internship, by analyzing text-based data stored in the shared online space, including self-review reports and feedback comments, supported by a quantitative text analysis tool MAXQDA. This TRIAD model affected the students' ability to communicate with people of another language and culture actively in order to make progress in the game development project, the ability to acquire project management skills as a part of a team working in game development, as well as to earn confidence by noticing the importance of individual decision-making by overcoming the problems between industry and academia. This reflects the significance of utilizing the TRIAD model in various fields involving student education, as the outcomes of this TRIAD model-based internship also relate to the found advantages of utilizing PBL in game development studies [12] [27], and other fields [31]. Moreover, the evaluation tool implemented in this study further clarified the detailed progress of the students' activities and the changes in their behavior, as well as the interaction of self-reviews and feedback. Furthermore, students had the chance to practice academic skills while also learning basic research skills both required in academia and the industry.

The results showed that the digital communication tool Slack functions as a supplement for internal and external communication across borders and time. As the remote collaboration between Sweden and Japan simply requires well developed communication tools and text analysis programs available for both academic and industrial actors, the essence of the TRIAD model is reproducible for other global industry-academia collaborations happening anywhere in the world. The online discussion space enables members to continue working together regardless of situations, such as the COVID-19 pandemic. The TRIAD model is adaptable towards the changes in our social and working environments.

This study also highlighted issues related to industry–academia game design projects, as the students struggled to balance academic requirements and the industry's limitations on technique, as well as to communicate with the staff, which led to wasting time dedicated to the game production project. The expected skills and plans between the two institutions were also different, leading to confusion and hindering the progress of the project. Further studies are needed to develop best practices for the TRIAD model by increasing the number of students because the small number of students limits the generalizability of this study and the variety of identified codes.

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