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20/F, Tower 5, China Hong Kong City, 33 Canton Road,
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Further Information
Website: http://sdiwc.net/ijeetdm/
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Effective Telecom Service Advertisements and Its Influence on Students Buying Behavior in Pakistan

Alina Khan
International Islamic University Islamabad
alinams2007@gmail.com

ABSTRACT
The aim of this research study is to find out the effectiveness of Pakistan telecom service advertisements in attracting university students and the factors that influence their buying behavior. The study was quantitative in nature and the methodology of non-probability convenient sampling employed to collect data from 400 respondents from different universities of twin cities Rawalpindi and Islamabad. The main variables were low-cost, entertainment, convenience/mobility and multimedia services.

The result showed that those telecom service advertisements that hold humorous appeal played their role in attracting consumers. Telecom service advertisements presented in entertaining way affects the consumer purchase decision. Whereas, the respondents has not given more attention to those advertisements that fulfills their daily need easily and have convenience factor in it. Majority of the youngsters have not given much importance to multimedia services as compared to other factors. Thus from the findings it is concluded that Pakistan telecom service advertisements are effective in attracting consumers and guides their purchase decision.

KEYWORDS
Telecom service advertisements, Low-cost, Entertainment, Convenience/mobility and Multimedia services.

1 INTRODUCTION
In this epoch of globalization and technology, effective advertising is considered as useful tool that influences the consumer buying behavior. Advertisements are one of the substantial ways to promote products as well as services to viewers and potential customers of the society (Ahmad and Arshad 2014). Marketers considered the advertisements as preeminent way to communicate and convince the consumers towards the product,
services or idea. This long lasting tool set product image on consumers mind (Abideen, Farooq and Latif 2011). Television is one of the most influential and powerful communication medium. Because of its powerful effects, advertisers used and relied on television for advertising of their products and services to entice their viewers (Rishante 2014).

Ranges of products are persistently on offer for consumer’s attention and consumption. Organizations are using the advertisements to create awareness by facilitating the positive brand image and educating the district benefits and features of offered brand (Ehrenberg, Barnard, Kennedy and Bloom 2002). Advertising are supporting people decision making by possessing the company brand more salient. Effective advertising affects customers and influences them to try the advertised products services (Shimp2007). Brands advertisements demands that consumers persistently making their decisions about the choice of product they wanted to consume and purchase. During this information, searching the purpose of advertisements is to inform, aware and persuade the consumers who did not come to point to take any decision (Ducoffe 1996).

Sketching the impact of advertising on consumer’s choice suggested two significant advantages. Firstly, it allowed access to large selection of naturally occurring stimuli. Secondly, it presented a natural observable result of successful persuasion that is the choice of advertised product (Russo and Chaxel 2010).

Advertising can influenced and its effects are well-established (Ailawadey and Neslin, 1998; Tellis, Chandy and Thaivanich 2000). Much written literature studies showed that how people processed information about the available products offers and making the choices in relevant choice situations (Ehrenberg et al. 2002) and increased the chances of purchasing the brands that otherwise difficult to choose (Machleit, Allen and Madden 1993). O'Donohoe (1994) suggested that there are certain uses perceived by the people through means of advertisements. Enjoyment in the form of entertainment, diversion and escapism are the important use that advertisements delivered to the people. The advertisements also do the surveillance role by providing the education as well as allowed the people to get familiar with the product. Leung (2005) talks about market competition of cellular companies offering their SMS rate as low as possible competing with each other in order to attract maximum people. Jun and Lee (2007) stated that people attitudes towards the mobile advertisements
depended on their purpose of using the mobile media. More they used mobile media for specific purpose more their attitudes are favorable towards mobile advertisements. Furthermore, people attitude towards mobile advertisements are directly relating with behavioral intentions for mobile advertisements. Mobility, multimediaservices and convenience are two important factors that influenced the public towards the advertisement (Jun and Lee 2007).

There are hardly any researches done in Pakistan about the telecom advertisement effectiveness on university student’s purchase decisions. In Pakistan, now in 2016, there are number of telecom companies like Ufone, Warid, Zong, Mobilink and Telenor are producing different advertisements to attract their viewers to catch their specific brand. These cellular companies are continuously putting efforts to prove themselves that they are better services provider and through advertisement, they are presenting their packages details.

There is a point of consideration that how these Pakistan cellular companies’ advertisements are affecting the people who are watching these advertisements and helps to make their decision on purchasing that product. Additionally, what factors (Entertainment, Mobility/Convenience, Low-cost and multimedia services) presenting in the cellular companies advertisements are influencing the people. Pakistan university students are the focus of this article because of the reason that youth are the one who used telecom services more. However, to researcher knowledge; there is no existing study on the relationship between telecom advertisements and university student’s choice in the context of Pakistan telecommunication services advertisements in Pakistan.

1.1 Statement of Problem

Now days, there are many Pakistan telecom service advertisements are seen on Television. All these advertisements are competing with each other to grab the attention of viewers especially the youth. It is important to examine the youth perception regarding the factors that influenced them to guide their purchase behavior. This research study deals to find out the Pakistan telecom service advertisements are effective in influencing the buying behavior of university students. In Pakistan there is no such study conducted which focuses on university students thinking about the factors in telecom service advertisements that affected them to buy that telecom brand services.
1.2 Objectives

The main objectives for conducting this research are as follows:

- To find out how much Pakistan telecom service advertisements is playing its strong role in influencing the students purchase decision.

- To investigate the humorous telecom service advertisement are more effective.

- To inspect that those Pakistan telecom service advertisements, which focuses on low cost services, are more effective in influencing the students purchase decisions.

- To observe out either Pakistan telecom advertisings is more effective in influencing the purchase decision as compared to interpersonal communication with friends and family.

1.3 Significance

Article findings will give benefits to the advertisers, advertisement designers and helpful for the advertising agencies to design and presents an effective advertisements. Advertisements producer will come to know about the factors in telecom service advertisements that attracts the attention of youth and guides their behavior to purchase their services. This article information will be supportive for the new cellular companies who wanted to launch their services in Pakistan and they will come to know about necessary elements that should be included in their advertisements to grab the interest of target audiences. The article will give new light to private cellular companies as well International cellular companies who wanted to start their telecom services in Pakistan.

2 LITERATURE REVIEW

Literature review for this research study covered the uses and gratification theory used as the base of this article as well as covered the youth perception regarding usage and influencing variables entertainment, mobility/convenience, low cost and multimedia services. This literature also focused on variables affecting the consumer behavior towards advertisements.

Uses gratification theory is a popular approach to understanding mass communication. The theory placed more focus on the consumer or audience instead of the actual message itself by asking, “what people do with media” rather than “what media do with the people” (Katz, 1959). Uses and gratification theory approach developed by Katz, Blumler and Gurevitch (1974) stated that media users played an active
role in selecting their media and thus goal oriented in media use. The theory assumed that audiences are not passive however took an active role in interpreting and integrating media into their own lives. The theory also comprised that audience is responsible for choosing media to meet their needs. This approach suggested that people used the media to fulfill the specific gratification (Katz, Blumler and Gurevitch 1974). Auher (2007) found that mobile phones were vital source of interpersonal communication for the young people. The common feature that all youngsters used were playing with the ringtones, caller screening etc. Along with the other gratification they get from the mobile phones were SMS and MMS. The customers used all these services to stay in connected with their social groups even when they are in their own home or in their other places. The gratification from the cell phones were closely linked to the customary interpersonal communication motives, which included inclusion, relaxation situational control, affection and pleasure.

The primary function that advertising played was to informed the public about the product or service rendered. Advertising also performed public service function by explaining something to the public which the public needs or has right to know. Today, entertainment is the result of advertising. Persuasive advertising attempted to convince the customer of the merits of buying something is it a product idea or service (Imitiaz 2008). Tsao and Sibley (2004) research showed that advertisement in free papers helped the readers what to purchase and due to this, they used variety of different product and services. Further, level of gratification depended on individual to individual. People moved towards the free paper in order fulfill the needs of information about the product and services from the advertisements.

Brand loyalty created among the users because of their contact with the mobile package advertisements. These advertisements have effects on the user buying decision. The purchasing behavior of the users directly correlated with their exposure to advertisements of different telecom service brands. Furthermore, the users were more satisfied when the advertisements showed the claims based on reality (Mahsud and Yaser 2010).

Leung (2007) studied that the strongest motive behind SMS using was entertainment factor. People also perceived that SMS and MMS as entertainment mode other than mode of communication. Entertainment included ringtone downloading, daily horoscope, news
headlines, weather reports etc. Entertainment factor was the motivation for media mobile media uses. However, this factor has less impact on the consumer’s reaction or adoption towards mobile advertisements (Jung and Lee 2007). Entertainment factor affected the consumer’s attitudes and this factor able to influenced people towards mobile advertisement. Furthermore, the entertainment has positive and direct influenced on people behavioral intentions of using the service. People considered mobile services advertisement uninteresting and non-entertaining when they compared these advertisements with other media advertisements (Tsang, Ho and Liang 2004). There was positive relationship between entertainment presented in advertisements perceived by young people and their purchasing intentions. People who found SMS advertisements more entertaining than this factor effected their buying decision and purchasing of the services (Alak and Alnawaz 2010). Leung (2007) stated that frequency of SMS using depended on the convenience and because of easily accessibility of these mobile services, people used SMS during travelling, walking in mall, restaurants etc. Students used the mobile services not only it provides entertainment to them but also for utilitarian purposes (Richard and Murphy 2006). Phau and Teah (2009) found that convenience factor influenced the young people and they used SMS because they think that it was easy and fast to use. Jun and Lee (2007) stated that convenience and mobility was two important factors that influenced the people towards mobile advertisements. There was positive relationship between perceived usefulness and intentions to participate. Consumers who found the advertisements useful and fulfills their needs they showed more willingness towards such advertisements. Consequently, when the consumers were convinced then they buy that services presented in the advertisements (Alak and Alnawaz, 2010).

Jung & Lee (2007) explained that not only the convenience and mobility factors influenced on the people intentions to attract towards mobile advertisements but there were also multimedia services that attracted the people towards advertisements (Jung and Lee 2007).

There is no literature researches found in Pakistan that focused on Pakistan Telecom service advertisements factors that influences the students that guides their purchase decision. There is knowledge gap exists as there are vast literature written internationally on this area of advertisements
however there is hardly any research studies conducted either internationally or locally found that focused on Pakistani university students factors influences buying behavior of telecom services.

3 METHODOLOGY

The idea behind this specific section is to divulge the rationale for research methodology, methods and strategies adopted in gathering the data for this research study. This particular part also revealed the operationalization of variables data that seeks to investigate the effectiveness of Pakistan telecom service advertisements in influencing the buying behavior of university students.

3.1 Research Design

The study was quantitative in nature and involved a survey from the educated youth of universities in an urban center, as they are the biggest user of television medium. According to Aliaga and Gunderson (2000) quantitative research method is explaining phenomenon by collecting numerical data that are analyzed using mathematically based methods. Survey research is one of the best research techniques for describing such population that are too large to observe it directly (Groves 2011).

3.2 Population

After visiting the websites of all major universities of Islamabad and Rawalpindi city, a rough estimates population was placed around 100,000 to 150,000 that are undergraduate, graduate and postgraduate level students studying in universities. For the sake of this article, the population analyzed comprised of students (both male and female) from the four universities in Islamabad and Rawalpindi.

3.3 Sample

Undergraduate students from each of four universities (International Islamic University Islamabad, Bahria University Islamabad, Fatima Jinnah University Rawalpindi and Quaid-e-AzamUniversity Islamabad) were the sample of this research study. This research article employed Non-probability sampling method. Undergraduate students of the selected universities were approached and asked to fulfill out the questionnaires. Four hundred questionnaires were distributed.

3.4 Operationalization of Variables

3.4.1 Low cost

Low cost means at low price. Pakistan Telecom service advertisements are providing the different packages at low rate in
order to grab the attention of maximum people.

3.4.2 Entertainment

Entertainment means form of enjoyment that telecom service advertisements are presenting in different styles and ways to attract the people.

3.4.3 Convenience/Mobility

Telecom service advertisements that focused on the benefits of their services by telling the people about the easy use of their services and the people have easy access to variety of services.

3.4.4 Multimedia Services (MMS)

Telecom services advertisements that included details about multimedia services (sending of messages along with sound files, images, video clips and graphics).

3.5 Data Collection

The researcher after selected the four major universities in Rawalpindi and Islamabad went to campuses of these universities approached the students and asked them to fill the questionnaire. The response rate was 100% and the respondents of these universities filled the entire 400 questionnaire.

3.6 Data Analysis

Four hundred questionnaires were distributed and all found valid and completed. Data tabulated by using SPSS to find out the answers of research questions.

4 RESULTS

This particular chapter analyzed the respondent’s response through administration of questionnaires.

Total 400 questionnaires were distributed and response rate was 100%. All response rates were included in final analysis. The data was thus compiled revealed that 50% of the respondents were male and 50% were female. The respondent ranged in age from 18 to 23 years old. Out of these, 28% were aged 20 years old, 20% were aged 22 years old, 19% were aged 19, 16% were aged 21, 11% were aged 18 and 6% were aged 23 years old.

Some general questions were asked from the respondents. In order to know which telecom service they were using now days the question was asked about the telecom connection they are currently using. The result showed that 46% of the respondents were using Ufone, 25% were using Telenor, 16% using Warid, 8% were using Mobilink, and only 5% respondents were using Zong. This means that majority
respondents were the Ufone customers and using their services.

Another question was asked from the people that what they are using prepaid connection or postpaid connection or both. The response clearly indicated that 87% of respondents were using prepaid connections, 7% were using postpaid connection while 6% respondents were using both prepaid and postpaid connections.

The question was asked from the respondents about the amount of spending money for recharging their mobile each month. The response from the respondents showed that there were 26% respondents who said that they spends Rs.200 for recharging their mobiles, 26% respondents were said Rs.500, 19% said Rs.300, 17% respondents said Rs.1000 and 12% respondents spends Rs.100 for recharging their mobiles.

Another question was asked from the respondents that which electronic telecom service advertisement they like most now a days. The result showed that 62% respondents like Ufone TV advertisement, 15% respondents like Mobilink, 8% respondents like Telenor, 8% respondents like Warid however only 7% of the respondents like Zong TV advertisement now a days.

Furthermore, the respondents were asked how often they buy any telecom service package because of its advanced multimedia. In response, 33% of the respondents replied that they never buy any telecom service packages because of its advanced multimedia, 31% of the respondents said sometimes, 17% said often, 15% said occasionally and only 4% of the respondents said that they regularly buy any telecom service package because of its multimedia services.

4.1 Research Questions

RQ1: Do telecom service advertisements played a strong role in influencing the customer’s purchase decision.

To determine this, respondents were asked that in their opinion telecom service advertisements played a strong role in influencing them to make the purchase decision. Results revealed that majority of students (71%) agreed that telecom service advertisements played an effective role in their lives as it effected their purchase decision of their telecom brand and its services (Table 1). Only few students (5%) were disagreed that telecom service advertising valued them in influencing their choice decision of telecom services (Table 1). Whereas 24% of the respondents remained neutral on the question of Pakistani
telecom service advertisements played a strong role in influencing them to make the purchase decision.

**Table 1. Role of Telecom Service Advertisements in Influencing Consumer Options**

<table>
<thead>
<tr>
<th>Options</th>
<th>N %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>100 (25)</td>
</tr>
<tr>
<td>Agree</td>
<td>184 (46)</td>
</tr>
<tr>
<td>Neutral</td>
<td>96 (24)</td>
</tr>
<tr>
<td>Disagree</td>
<td>12 (3)</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>8 (2)</td>
</tr>
</tbody>
</table>

Second question was asked from the respondents that how often the telecom service advertisement do affected their purchasing decision. As indicated in table 2, majority of respondents agreed that telecom service advertisement do affected their buying behavior towards specific telecom brand and their services. Only 26% of respondents said that telecom service advertisement never influenced their purchase behavior of telecom services.

**Table 2. Purchasing Decision Affected by Telecom Service Advertisement**

<table>
<thead>
<tr>
<th>Options</th>
<th>N %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>104 (26)</td>
</tr>
<tr>
<td>Occasionally</td>
<td>56 (14)</td>
</tr>
<tr>
<td>Sometimes</td>
<td>172 (43)</td>
</tr>
<tr>
<td>Often</td>
<td>48 (12)</td>
</tr>
<tr>
<td>Regularly</td>
<td>20 (5)</td>
</tr>
</tbody>
</table>

**RQ2: Do telecom service advertisements on electronic media have greatest influence?**

To check in which medium telecom service advertisements have strongest influence on university students. To determine this, respondents were asked that telecom service advertisements in which medium influenced them more often. The respondent responses amazed the researcher. Results clearly indicated that telecom service advertisements on TV have the greatest influence. As 67% of students responded that, they telecom service advertisements presented on electronic media (TV) have greatest influence (Table 3). However, 8% students responded print, 20% said internet and only 5% respondents replied that radio was the strongest influencing medium for telecom service advertisements.

**Table 3. Influencing Medium of Telecom Service Advertisement**

<table>
<thead>
<tr>
<th>Options</th>
<th>N %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print</td>
<td>32 (8)</td>
</tr>
<tr>
<td>Electronic</td>
<td>268 (67)</td>
</tr>
<tr>
<td>Radio</td>
<td>20 (5)</td>
</tr>
<tr>
<td>Internet</td>
<td>80 (20)</td>
</tr>
</tbody>
</table>

**RQ3: Is advertising more effective in influencing the purchase decision as compared to**
interpersonal communication with friends and family?

To find the answer of this research question, two questions were asked from the respondents. Firstly, which source has convinced them to use the specific telecom service they are using now? As indicated in the result, 43% of respondents said that telecom service advertisements were effective tool that influenced them to use telecom services as compared to friends and family suggestions. Whereas, 32% youth said that friends has given them suggestion to use certain telecom services and they buy it. Only 25% respondents said that their family guided them to purchase the specific telecom service brand.

Table 4. Convincing Source to Use Specific Telecom Service

<table>
<thead>
<tr>
<th>Options</th>
<th>N%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advertisements</td>
<td>172  (43)</td>
</tr>
<tr>
<td>Family</td>
<td>128  (32)</td>
</tr>
<tr>
<td>Friends</td>
<td>100  (25)</td>
</tr>
</tbody>
</table>

RQ4: Are telecom service advertisements, which focus on low cost more effective in influencing the purchase decision?

To find this, respondents were asked that which factor in their opinion affected their service purchase decision. Results showed in table five that 25% of the respondents said that those telecom service advertisements in which low cost packages details were presented guide and influenced them in their purchase decisions. However, those advertisements in which quality service details were presented 24% of the youth did not think as effective in influencing their buying behavior. While 14% of respondents said wide coverage, 34% said variety of packages details presented in telecom advertisements helped them to decide which telecom services brand they wanted to purchase. Only 3% of respondents answered multimedia services.

Table 5. Factor affects Service-Purchasing Decision

<table>
<thead>
<tr>
<th>Options</th>
<th>N%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Service</td>
<td>96   (24)</td>
</tr>
<tr>
<td>Wide Coverage</td>
<td>56   (14)</td>
</tr>
<tr>
<td>Low-cost</td>
<td>100  (25)</td>
</tr>
<tr>
<td>Variety of Packages</td>
<td>136  (34)</td>
</tr>
<tr>
<td>Multimedia Services</td>
<td>12   (3)</td>
</tr>
</tbody>
</table>

RQ5: Are humorous telecom advertisements more effective?

Researcher main aim was to know that what factors in telecom service advertisements influenced the youth to buy the specific brand services. To verify this, the respondents were
asked that which type of telecom service advertisements appealed most. Results in table 6 clearly revealed that those telecom service advertisements in which advertisers used humorous (entertainment) attraction appeals to youth and represented by 40% of the respondent agreed. While telecom advertisements in which celebrity were used did not attract the youth whereas 36% of youth said that informational telecom advertisements were appealed to them. However, only 3% of respondents agreed that telecom advertisements that focused on multimedia services appealed to them. Respondents (12%) also did not like advertisements in which emotional appeal was used to attract their attention.

### Table 6. Type of Telecom Service Advertisements Appeals the Most

<table>
<thead>
<tr>
<th>Options</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humorous</td>
<td>160</td>
<td>(40)</td>
</tr>
<tr>
<td>Emotional</td>
<td>48</td>
<td>(12)</td>
</tr>
<tr>
<td>Informational</td>
<td>144</td>
<td>(36)</td>
</tr>
<tr>
<td>Celebrity</td>
<td>36</td>
<td>(9)</td>
</tr>
<tr>
<td>Multimedia services</td>
<td>12</td>
<td>(3)</td>
</tr>
</tbody>
</table>

5 DISCUSSION

Telecom companies come to know the importance of advertisements now days. It is one of the strongest strategies to reach the target audiences especially the youth. In recent times, wide variety of advertisements is showing through different media. The role of advertisements in recent era is not only to aware the people about the particular services but also to attract the maximum people towards those specific services. Telecom companies made exciting and interesting advertisements to grab younger audiences to use their particular service. At current times, there is competition going on between different telecom companies that are clearly competing in different mediums. Each telecom companies try to highlight their particular services to attract the maximum people e.g. some are providing low cost SMS packages, others offering new multimedia services while some focuses on the entertainment factor in their advertisements.

The aim of this article was to examine the effectiveness of Pakistan telecom service advertisement in attracting young consumers. The research also focuses on of the Pakistan telecom service advertisements that influence consumer behavior to utilize their services.

After conducting the research, it was found that 100% of youth are using different telecom services and they have knowledge about telecom
companies. The result indicated that majority of youth considered that electronic medium is the strongest medium for telecasting of telecom advertisements. Electronic advertisements is far more effective as it has both audio and video which people can see, listen and understands it in much better way. This is in accordance with research conducted by Ranjbarian, Shaemi and Jolodar (2011) who asserted that TV advertisements are effective. In fact, TV advertisements are successful in taking attention of audiences, creating interest and desire for action and eventually are effective in behavioral change.

Results further revealed that youth was also attracted towards such telecom advertisements that focused on services that ensure convenience and mobility factor and provide the services that assured them of their easy lifestyles. This is in accordance with the research of Jung and Lee (2007) who asserted that convenience and mobility are two vital factors that influenced the people towards mobile advertisements. Similarly, another research conducted by Phau and Teach (2009) showed that convenience factor influenced the younger people and they used SMS because they think that it is easy and fast to used.

Telecom service advertising is more effective in influencing the purchase decision as compared to interpersonal communication with friends and family. Advertisements helped the youngsters to give insight of telecom services offered by different brands. So consumers can easily decide by comparing the offers and these advertisements guided them to decide which services they wanted to choose.

Advertisements that focused on low cost are not much effective in influencing purchase decision. As the respondents were younger generation they feel that sometimes, telecom service packages offered by companies are affordable and they managed all these facilities in their pocket money. Results are from youth oriented response so their purchasing decision is sometimes affected by the telecom services, which provide different packages and facilities but in low cost, which is easily manageable by them in their pocket money. Furthermore, sometimes, youngsters take low cost services as cheaper and fast way of communication, which connects them with other people.

Advanced multimedia services of telecom companies are more expensive and unaffordable by the young generation, so they do not buy or prefer any telecom package that
contains advance multimedia services.

Telecom service advertisements that used humorous appeal are most effective. The acquired results indicated that young people are more attracted towards the advertisements that are entertaining to them and they love to avail their services. Different SMS packages, internet services are presenting in entertaining way and youngsters wants them. This is related to the study conducted by Tsang, Ho and Liang (2004) who argued that consumer attitudes are affected by the entertainment factor and this factor able to influenced much the people attitude towards mobile advertisements. Moreover, the entertainment has positive and direct influenced on the people behavioral intentions of using the service. Other researchers Alak and Alnawaz (2010) found that there is a positive relationship found between entertainment perceived by young people and their purchasing intentions towards such advertisements. People who found SMS advertisements as more entertaining, this entertainment factors affected their decision of buying or purchasing the services. Humorous appeal is one of the advertising appeals used to grab more customers. Advertisers assure to maintain the level of interest by making every advertisement as more humorous than others make. This is actually helping them to win their customers more. Other than humorous appeal, information is more preferred as it gives the deep insight of the service, its advantages and reason to use the particular service from others. This is related to the research conducted by Haller (1974) who stated that the viewer’s not only just take the advertisements as source of information about the product or its feature they also derived pleasure and fun from the way they are being shown.

6 CONCLUSION

The aim of this article is to examine the effectiveness of telecom service advertisements in attracting consumer and the factors that influenced consumer behavior. The research study was quantitative in nature and the methodology of non-probability convenient sampling was employed to collect the data from 400 respondents from different Pakistani universities. The main variables in the study were low cost, Entertainment, Convenience/Mobility and Multimedia services. The result showed that telecom service advertisements in which humorous appeal is used play their role in attracting consumers. Telecom service advertisements presented in entertaining way affected the customer decision. Whereas, the respondents did not
give more attention to those advertisements that fulfills their daily need easily and have convenient factor in it. Majority of the youngsters did not give much importance to multimedia services as compared to other factors. Findings approved the fact that advertisements are influencing consumer to make the purchasing decision with reference to telecom services as 71% of the respondents agreed to it. Advertisements are thus, the only source to convey the message and packages information provides the deep insight to the company approach and attitudes towards consumers in general. Therefore, the finding concluded that Pakistan telecom service advertisements are effective in attracting the university students and guides their purchasing decision.

7 RECOMMENDATIONS

Existing telecom service companies should pay more focus on entertainment factor in making their advertisements. Entertaining advertisements can increase the number of telecom service users. Even new international telecom companies that are interested in lushing telecom service in Pakistan should promote their product through making entertaining advertisement that attracts the new customers especially youth in Pakistan.

Researcher recommended following recommendation for future research in this area of field. Survey methodology was adopted for this article. However, for future research, researchers can use content analysis for further in depth study of this topic. For forthcoming research, detailed interviews can also be taken from different telecom companies and advertising agencies e.g. telecom companies who design telecom ads. It will make the study more focus. The researchers can also do further research by taking a single variable to examine its influence on consumer buying decision e.g. low cost factor can be studied in detail to know how it change the customer attitude to buy certain telecom service.

8 LIMITATIONS

Printed survey was limited to respondents studying in Islamabad and Rawalpindi universities because of researcher’s expediency. Finally, the biggest problem researcher faced was the loadsheeding because most of research work has done using different computer applications. However, the research is done with great patience. In spite of all the limitations and problems researcher faced in compiling this article, it is an authentic research work.
REFERENCES


ABSTRACT

The Massive Open Online Courses (MOOC) concept has apprehended the interest of all actors in higher education. MOOC platforms are considered as a crucial source of information for both learners and professors by offering hundreds of courses around the world. However, this technology has faced many challenges, particularly their low completion rates. The present paper proposes the architecture of a framework using Fuzzy Analytic Hierarchy Process algorithm (Fuzzy-AHP) to determine the triangular weight of the courses from the most widespread MOOCs in the literature. Weights of the courses are calculated by fuzzy numbers in line with the learning profile. The outcome of the proposed framework is to improve teaching effectiveness, facilitate learning among learners, encourage long life learning and maximize motivation as well as reducing the dropout rates.

KEYWORDS

MOOC, reusability, Fuzzy AHP, dropout rate.

1 INTRODUCTION

One of the challenges faced by institutions of higher education is the increasing number of university students and the low rate of supervision. Thereby, many universities have embraced technological aspects of MOOCs [1]. However, to produce quality and pertinent MOOCs, diverse backgrounds are involved such content developers, domain experts, instructional designers, pedagogues, graphic designers and programmers, etc. MOOCs are expensive to produce as is a team effort, involving considerable amount of time investment of several actors. If some large universities can afford them, it is not the case for smaller ones [2].

Subsequently, after many meetings we have decided to reuse and capitalize the remaining MOOC in the literature in accordance with their privacy policy and our requirements. In parallel, we will develop courses that meet the competencies of our team. We are interested in this paper to the issue of the reusability of the most prominent MOOC in the literature to build the appropriate pedagogical path suiting the learner needs, capacities, preferences, etc.

The remainder of this paper is structured as follow. We will firstly begin by presenting the AHP Method and the fuzzy AHP. We discuss next, the MOOC capitalization concept as a solution to benefit. Afterwards, we explore and present the architecture of the proposed system that implements Fuzzy AHP. Finally, we discuss the ability of this work to achieve the worth reusability of the existing MOOC.

2 BACKGROUND

2.1 The AHP Method

Analytic hierarchy process (AHP) is a Complex Decision Analysis Theory proposed by Thomas Saaty, a consultant for the US government and a professor at the Wharton School of Business in 1980, and it was subsequently extended by Graan and Lootsma 1981, which allows the most credible decisions to be made by taking several factors into account. The AHP structures the criteria hierarchically, then compares them in peers, in order to design, prioritize, justify, and choose the right solution for the most complex situations.

The first step is to designate the general objective on which we will base our decision, then the possible solutions or alternatives, and the criteria to be taken into consideration [3] [4].
In some cases, (complex decisions) we can have several levels of criteria (Criteria, sub-criteria ...) the figure below presents the hierarchical architecture of the AHP method [5].

![Hierarchical architecture of the AHP method](image)

**Fig 1.** Hierarchical architecture of the AHP method [6]

The next step is to evaluate the set of criteria for each hierarchical level in relation to that of the higher hierarchical level, according to a value scale proposed by Saaty [7]:

**Table 1.** Value scale proposed by Saaty

<table>
<thead>
<tr>
<th>Degrees of importance</th>
<th>Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance</td>
<td>Two activities contribute equally to the objective</td>
</tr>
<tr>
<td>3</td>
<td>Moderate importance of one over another</td>
<td>Experience and judgment strongly favor one activity over another</td>
</tr>
<tr>
<td>5</td>
<td>Essential or strong importance</td>
<td>Experience and judgment strongly favor one activity over another</td>
</tr>
<tr>
<td>7</td>
<td>Very strong importance</td>
<td>An activity is strongly favored and its dominance demonstrated in practice</td>
</tr>
<tr>
<td>9</td>
<td>Extreme importance</td>
<td>The evidence favoring one activity over another is of the highest possible order of affirmation</td>
</tr>
<tr>
<td>2,4,6,8</td>
<td>Intermediate values between the two adjacent judgments</td>
<td>When compromise is needed</td>
</tr>
<tr>
<td>Reciprocals</td>
<td>If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i</td>
<td></td>
</tr>
</tbody>
</table>

This allows us to build comparative matrices; its general form is as follows:

$$M = \begin{pmatrix} C_{11} & C_{12} & \cdots & C_{1n} \\ C_{21} & C_{22} & \cdots & C_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ C_{n1} & C_{n2} & \cdots & C_{nn} \end{pmatrix}$$

(1.1)

With

$$C_{ij} = \frac{1}{C_{ji}}$$

Then, to obtain the weight of each criterion (The higher the weight value is, the greater is the criterion),

It is necessary to first construct the normalized matrix, for this, it is necessary to calculate the sum of each column: $$\sum_{i=1}^{n} C_{ij}$$. Then each of the values of the column is divided by this sum: $$\frac{C_{ij}}{\sum_{i=1}^{n} C_{ij}}$$. The normalized matrix is thus obtained in the following form:

$$M_n = \begin{pmatrix} N_{11} & N_{12} & \cdots & N_{1n} \\ N_{21} & N_{22} & \cdots & N_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ N_{n1} & N_{n2} & \cdots & N_{nn} \end{pmatrix}$$

(1.2)

With

$$N_{ij} = \frac{C_{ij}}{\sum_{i=1}^{n} C_{ij}}$$

The weight of each criterion i is calculated by calculating the mean of the corresponding line:

$$P_i = \frac{\sum_{j=1}^{n} N_{ij}}{n}$$

(1.3)

With $$\sum_{i=1}^{n} P_i = 1$$ [n is the number of the compared criteria]
These steps are repeated for each hierarchical level. Finally, it is necessary to check the consistency and the reliability of the result. The inconsistency in our results may be due to the fact that a criterion is poorly judged compared to one or more other criteria. The consistency ratio (RC) will allow us to detect any anomaly in our calculations.

First of all, it is necessary to calculate the index of consistency CI (Consistency Index) [8]:

$$ CI = \frac{\lambda_{max} - n}{n - 1} \quad \text{and} \quad b_i = \frac{\sum_{j=1}^{n} p_{ij} \cdot N_{ij}}{p_i} $$  \hspace{1cm} (1.4)

With \( \lambda_{max} \): Maximum eigenvalue.

Then the Consistency Ratio is calculated as follows:

$$ RC = \frac{CI}{IA} $$  \hspace{1cm} (1.5)

IA is the random index obtained from the following table\(^1\):

<table>
<thead>
<tr>
<th>Size of the matrix</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>0.05</td>
<td>0.09</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
<td>1.49</td>
</tr>
</tbody>
</table>

The RC value must be less than or equal to 10% [7] [9]. Otherwise comparisons must be repeated in pairs to reduce inconsistencies.

We notice that The consistency ratio cannot be calculated for a size 2 matrix, which in this case the inconsistency does not exist.

The AHP is easy to implement, it is widely used within companies, and taught in many universities. This method allows to divide the most complex decision problems into hierarchical levels (the criteria of each level are interdependent), with a scale of values that expresses the preferences of the decision-makers, it also allows to rally the qualitative and quantitative criteria [10] where each criterion contributes to the final decision [11]. However, this method has had some criticism mainly on the fact that, the association of a numerical scale with another semantic is restrictive, so it introduces inaccurate numerical values [12]. To cure these criticisms, the method has undergone several extensions, the case of taking into account the uncertainty (stochastic AHP), and the blur (fuzzy AHP) in the expression of judgments [12].

### 2.2 The AHP Method and the Fuzzy Logic:

The fuzzy extension of the AHP method (Fuzzy AHP) was born thanks to the work of Van Laarhoven and W. Pedrycz in 1983. Both researchers rely on the fact that the ratios displayed in a Matrix, from which the appropriate weights can be extracted, are generally fuzzy. These ratios express a decision maker's preferences about the importance of a pair of factors. Therefore, the FAHP (Fuzzy AHP) method invites decision-makers to express their opinions via fuzzy values with triangular membership functions [13].

For example, when the two criteria C1 and C2 are compared and the first one is much larger than the other, according to the AHP method, the value associated with this judgment is 5. According to The FAHP method, a triangular fuzzy number (TFN) is associated with each verbal judgment \( \tilde{x} = (l; m; u) \), from the example given we obtain the TFN: \( \tilde{x}_{12} = (4,5,6) \). There are several scales that associate triangular fuzzy numbers with numerical values and verbal judgments. Below are the most used scales:

<table>
<thead>
<tr>
<th>Numeric value</th>
<th>Verbal judgment</th>
<th>TFN</th>
<th>Reciprocal TFN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance of the two criteria</td>
<td>(1,1,1)</td>
<td>(1,1,1)</td>
</tr>
<tr>
<td>2</td>
<td>Intermediate value</td>
<td>(1/2, 3/4, 1)</td>
<td>(1,4/3, 2)</td>
</tr>
<tr>
<td>3</td>
<td>One criterion is a little more important than the other</td>
<td>(2/3, 1, 3/2)</td>
<td>(2/3, 1, 3/2)</td>
</tr>
</tbody>
</table>

---

\(^1\) Saaty has defined values for comparison matrices of different sizes [7].
Table 4. Second example of the triangular fuzzy numbers of the AHP method [16]

<table>
<thead>
<tr>
<th>Numeric value</th>
<th>Verbal judgment</th>
<th>TFN</th>
<th>Reciprocal TFN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance of the two criteria</td>
<td>(1, 1, 1)</td>
<td>(1, 1, 1)</td>
</tr>
<tr>
<td>2</td>
<td>Intermediate value</td>
<td>(1, 2, 3)</td>
<td>(1/3, 1/2, 1)</td>
</tr>
<tr>
<td>3</td>
<td>One criterion is a little more important than the other</td>
<td>(2, 3, 4)</td>
<td>(1/4, 1/3, 1/2)</td>
</tr>
<tr>
<td>4</td>
<td>Intermediate value</td>
<td>(3, 4, 5)</td>
<td>(1/5, 1/4, 1/3)</td>
</tr>
<tr>
<td>5</td>
<td>One criterion is much more important than the other</td>
<td>(4, 5, 6)</td>
<td>(1/6, 1/5, 1/4)</td>
</tr>
<tr>
<td>6</td>
<td>Intermediate value</td>
<td>(5, 6, 7)</td>
<td>(1/7, 1/6, 1/5)</td>
</tr>
<tr>
<td>7</td>
<td>One criterion is very much more important than the other</td>
<td>(6, 7, 8)</td>
<td>(1/8, 1/7, 1/6)</td>
</tr>
<tr>
<td>8</td>
<td>Intermediate value</td>
<td>(7, 8, 9)</td>
<td>(1/9, 1/8, 1/7)</td>
</tr>
<tr>
<td>9</td>
<td>One criterion is extremely more important than the other</td>
<td>(8, 9, 10)</td>
<td>(1/10, 1/9, 1/8)</td>
</tr>
</tbody>
</table>

Table 5. Third example of the triangular fuzzy numbers of the AHP method [16]

<table>
<thead>
<tr>
<th>Numeric value</th>
<th>Verbal judgment</th>
<th>TFN</th>
<th>Reciprocal TFN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance of the two criteria</td>
<td>(1, 1, 1)</td>
<td>(1, 1, 1)</td>
</tr>
<tr>
<td>2</td>
<td>Intermediate value</td>
<td>(1, 2, 4)</td>
<td>(1/4, 1/2, 1)</td>
</tr>
<tr>
<td>3</td>
<td>One criterion is a little more important than the other</td>
<td>(1, 3, 5)</td>
<td>(1/5, 1/3, 1)</td>
</tr>
<tr>
<td>4</td>
<td>Intermediate value</td>
<td>(2, 4, 6)</td>
<td>(1/6, 1/4, 1/2)</td>
</tr>
<tr>
<td>5</td>
<td>One criterion is much more important than the other</td>
<td>(3, 5, 7)</td>
<td>(1/7, 1/5, 1/3)</td>
</tr>
<tr>
<td>6</td>
<td>Intermediate value</td>
<td>(4, 6, 8)</td>
<td>(1/8, 1/6, 1/4)</td>
</tr>
<tr>
<td>7</td>
<td>One criterion is very much more important than the other</td>
<td>(5, 7, 9)</td>
<td>(1/9, 1/7, 1/5)</td>
</tr>
<tr>
<td>8</td>
<td>Intermediate value</td>
<td>(6, 8, 9)</td>
<td>(1/9, 1/8, 1/9)</td>
</tr>
<tr>
<td>9</td>
<td>One criterion is extremely more important than the other</td>
<td>(7, 9, 10)</td>
<td>(1/9, 1/8, 1/7)</td>
</tr>
</tbody>
</table>

The same as the AHP, the first step of the FAHP method is to construct the fuzzy judgment matrix:

\[
\tilde{A} = \begin{pmatrix}
(1,1,1) & \frac{1}{u_{12}} & \frac{1}{u_{13}} & \frac{1}{u_{14}} \\
\frac{1}{v_{21}} & (1,1,1) & \frac{1}{v_{23}} & \frac{1}{v_{24}} \\
\frac{1}{v_{31}} & \frac{1}{v_{32}} & (1,1,1) & \frac{1}{v_{34}} \\
\frac{1}{v_{41}} & \frac{1}{v_{42}} & \frac{1}{v_{43}} & (1,1,1)
\end{pmatrix}
\] (2.1)

With \(\tilde{a}_{ij}\) is a triangular fuzzy number

\[
\tilde{a}_{ij} = \left( \frac{1}{u_{ij}}, \frac{1}{m_{ij}}, \frac{1}{l_{ij}} \right)
\]

Then, we must determine the fuzzy synthetic extent for each criterion [17]:

\[
\tilde{S}_i = \sum_{j=1}^{n} \tilde{a}_{ij} \quad \left( \sum_{k=1}^{n} \tilde{a}_{ik} \right)^{-1} \text{with } i, j = 1, ..., n
\] (2.2)

Then we must calculate the degree of possibility V that a fuzzy number \(\tilde{S}_i\) is superior to another \(\tilde{S}_j\) [18].

\[
V(\tilde{S}_i \geq \tilde{S}_j) = \begin{cases} 
1 & \text{If } \tilde{m}_i \geq \tilde{m}_j \\
0 & \text{If } \tilde{l}_j \geq \tilde{u}_i \\
\left( \frac{\tilde{l}_j - \tilde{u}_i}{\tilde{m}_i - \tilde{u}_i} \right) & \text{If } \text{Not }
\end{cases}
\] (2.3)

With \([i, j] = 1, ..., n \text{ and } j \neq i\)

And the degree of possibility for each \(\tilde{S}_i\) compared to n fuzzy numbers as follows [18]:

\[
V(\tilde{S}_i \geq \tilde{S}_j| j = 1, ..., n; j \neq i) = \min_{j \in \{1, ..., n\} \setminus \{i\}} V(\tilde{S}_i \geq \tilde{S}_j)
\] (2.4)
This last makes it possible to know the importance of the criterion $i$ compared to a set of criteria [12]. Finally, the priority vector $W = (w_1, \ldots, w_n)$ must be defined for the fuzzy judgment matrix [19]:

$$W_i = \frac{\sum_{j=1}^{n} w(j)}{\sum_{k=1}^{n} w(k)}$$

With $[i = 1, \ldots, n]

3 SYSTEM ARCHITECTURE:

In this section we illustrate some functionalities of our system which implements the FAHP presented above. The architectural design of the proposed system is composed by three main components:

- **Information collector:** On one hand, from the user’s personal information, extracted during his first inscription at the platform (User Profile Information). Each information is qualified either as a Domain Dependent Data, for instance the information related to the Academics Background, Background Knowledge, and Qualifications. Or as a Domain Independent Data, as for the information related to Motivation, Interests, and skills.

  On the other hand, from the learning preferences, (user preferences) that the user will bring when he will need to search for a course, chapter...

- **Automatic update of database:** using the research algorithms that we will develop, our database will automatically be feed with new online courses tailored by universities, schools, and platforms that interest us.

- **Weight calculator:** The selection of the research criteria of the learning materials by the user, will allow us to calculate the weight of each of its criteria via the Fuzzy AHP method, and to classify the courses, route, chapter, ... by priority order.

4 THE FUZZY AHP APPLIED TO OUR CASE:

During his first visit to the platform, the user is required to fill in a registration form, and then he is automatically redirected to the platform, where he can select his searching preferences according to a set of criteria: language ($L$), Course Type ($N$), Simple courses, Chapter, course; With or without certification ($C$); Duration ($D$); Free or paid ($G/P$). So based on this information, we will extract all the data that responds to the criteria, and rank them in order of priority using the Fuzzy AHP method. After completing his course, chapter ..., the user is asked to answer some few questions (satisfied or not, suggestions to improve the platform ...).

### Table 6. Verbal judgments and corresponding triangular fuzzy numbers

<table>
<thead>
<tr>
<th>Verbal judgment</th>
<th>$l_i$</th>
<th>$m_i$</th>
<th>$u_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely important (EI)</td>
<td>7/2</td>
<td>4</td>
<td>9/2</td>
</tr>
</tbody>
</table>
Then, in order to construct our fuzzy judgment matrix, we will first of all compare our criteria based on the table above:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>5/2</th>
<th>3</th>
<th>7/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>more important (MI)</td>
<td>3/2</td>
<td>1</td>
<td>1/2</td>
</tr>
<tr>
<td>very important (FI)</td>
<td>1/2</td>
<td>1</td>
<td>1/2</td>
</tr>
<tr>
<td>A little important (LI)</td>
<td>1/2</td>
<td>1</td>
<td>1/2</td>
</tr>
<tr>
<td>Equal importance (IE)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 7. Criterias peer comparison

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>N</th>
<th>C</th>
<th>D</th>
<th>G/P</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>I</td>
<td>TI</td>
<td>TI</td>
<td>EI</td>
<td>PI</td>
</tr>
<tr>
<td>N</td>
<td>1/TI</td>
<td>I</td>
<td>PI</td>
<td>EI</td>
<td>1/TI</td>
</tr>
<tr>
<td>C</td>
<td>1/TI</td>
<td>1/PI</td>
<td>1</td>
<td>EI</td>
<td>TI</td>
</tr>
<tr>
<td>D</td>
<td>1/EI</td>
<td>1/EI</td>
<td>1/EI</td>
<td>I</td>
<td>1/TI</td>
</tr>
<tr>
<td>G/P</td>
<td>1/PI</td>
<td>TI</td>
<td>1/TI</td>
<td>TI</td>
<td>1</td>
</tr>
</tbody>
</table>

Using (2.2) we obtain the fuzzy synthetic extent for each criterion:

\[
\hat{S}_L = (10.11, 12.14) \odot (\frac{1}{54.5}, \frac{1}{33.4}, \frac{1}{54.4}) = (0.18, 0.31, 0.43)
\]

\[
\hat{S}_N = (566.66, 666.73) \odot (\frac{1}{45.4}, \frac{1}{24.2}, \frac{1}{45.4}) = (0.10, 0.17, 0.24)
\]

\[
\hat{S}_C = (788.93, 33.10) \odot (\frac{1}{45.4}, \frac{1}{24.2}, \frac{1}{45.4}) = (0.14, 0.24, 0.33)
\]

\[
\hat{S}_D = (194.23, 30.11) \odot (\frac{1}{45.4}, \frac{1}{24.2}, \frac{1}{45.4}) = (0.03, 0.05, 0.06)
\]

\[
\hat{S}_{G/P} = (688.83, 33.99) \odot (\frac{1}{45.4}, \frac{1}{24.2}, \frac{1}{45.4}) = (0.12, 0.21, 0.30)
\]

Then using (2.3) and (2.4) we obtain the degree of possibility for each \(\hat{S}_i\) as follows:

\[
V(\hat{S}_L \geq \hat{S}_N, \hat{S}_C, \hat{S}_D, \hat{S}_{G/P}) = \text{Min}(1, 1, 1, 1) = 1
\]

\[
V(\hat{S}_L \geq \hat{S}_N, \hat{S}_C, \hat{S}_D, \hat{S}_{G/P}) = \text{Min}(0.30, 0.58, 1, 0.75) = 0.3
\]

\[
V(\hat{S}_L \geq \hat{S}_N, \hat{S}_C, \hat{S}_D, \hat{S}_{G/P}) = \text{Min}(0.68, 1, 1, 1) = 0.68
\]

\[
V(\hat{S}_L \geq \hat{S}_N, \hat{S}_C, \hat{S}_D, \hat{S}_{G/P}) = \text{Min}(0.40, 0.68, 0.53, 0.60) = 0.40
\]

\[
V(\hat{S}_L \geq \hat{S}_N, \hat{S}_C, \hat{S}_D, \hat{S}_{G/P}) = \text{Min}(0.54, 1, 0.84, 1) = 0.54
\]

Finally, we obtain the weight vectors \(W = (1, 0.3, 0.68, 0.40, 0.54)\) via (2.5). It will allow us to classify the criteria, also the courses offered to the learners in order of priority.

**5 CONCLUSION AND FUTURE WORK:**

Our approach is to use the fuzzy AHP method to provide learners with courses that goes with their requirements to the maximum. This method will enable us to classify the courses requested by our learners in priority order, according to the criteria and preferences of this latter. There is no point in offering a course for a learner who needs only one chapter. This will allow us to compensate in some way some issues related to the drop-out rate.

As a first step, we intend to add other criteria in the selection of courses. Therefore, we seek to examine the possibility of giving learners the possibility of choosing the weight of each criterion compared to each other in order to better meet the needs of the learners.

**REFERENCES**


DrSust: Adaptive Tutoring System to Increase Students’ Engagement in Programming Learning

Nejood Eltegani
Sudan University of Science and Technology, Sudan
Email: nejood.phd@gmail.com

and

Laurie Butgereit
Nelson Mandela Metropolitan University, South Africa
Email: laurie.butgereit@nmmu.ac.za

ABSTRACT

At Sudan University of Science and Technology (SUST), programming fundamentals is a core subject to computing students which is usually taught during their first year of study. Staff teaching programming subject realized that the course is time demanding and students required close follow up in and out of class. If diagnosis of learning difficulties and timely support to students is not provided; struggle and frustration will happen and this will eventually lead to students’ disengagement. Disengagement results in students not utilizing all the possible time they can in performing programming related tasks. In this work an adaptive system was designed and built iteratively to help students in learning programming and to identify the engaging aspects of learning. Additional functionalities and improvements were added to the system after each system’s iteration depending on the usage pattern derived from students log data. After running the system for three iterations the attributes that were used for modeling the students and hence adapt the system are: navigation pointer, language, quizzes Level, exercises level and learning style.

KEYWORDS

Students’ engagement, Students disengagement, Adaptive system, Student’s model.

1 INTRODUCTION

Technology enhanced learning is a field that tries to find ways of enhancing learning through technological means. Researchers are investigating the effectiveness of using the different available technologies for learning. Personalized learning could help in providing detailed help and guidance to different students based on students’ description or students’ models. Personalized learning or adaptive systems that rely on user model/profile to arrange or display contents exist [1] for example:

- Information retrieval and filtering systems (Recommender systems): uses user’s interests in terms of keywords or concepts to find relevant documents to users.
- Intelligent tutoring systems (ITS): aim at providing personalized educational activities and individual feedback to users.
- Adaptive Hypermedia (AH) and Adaptive Educational Systems (AES): employ the user knowledge models to display contents that are believed to be of interest to users.

The common denominator between the above mentioned systems is the need to describe the users to the system which will aid in selecting the appropriate actions.

As an example of a system that arranges the retrieval of the content and recommends a learning path to students is a work described in [2] that helps both tutors and students to find learning materials. This system reduces the looping or materials revisiting by students and provides the materials that is suitable for the individual learners.

Recommender systems are used to improve the students’ learning experiences from the vast material available online about a particular topic. The materials found for education could range from texts (explanations) to interactive content such as exercises and questions. As the levels of students differ, a personalized recommendation is desired to select materials that are optimal for the students. The purpose of the recommender system is to select items with optimal difficulty that is to say difficult enough to keep them occupied to solve it, and not too difficult to make them quit.[2]

In an adaptive system a minimal number of components should be displayed to the user to avoid overloading the user (cognitive overload)
Creating Adaptive Systems focuses on two major aspects namely: the structure of the system and the content to be displayed.

Both adaptation and adaptivity are based on the user interests and preferences. Adaptable interface is about following the choices of the user with regard to the appearance of the interface or locating site content based on users’ preferences (explicit). To implement an adaptable interface, user choices are registered and it is registered as part of the user model. While adaptivity is the ability of the system to recommend to a user contents believed to be of her/his interests (implicit). Adaptive systems record and make choices based on the interaction with the interface and monitor selective actions performed by the user and hence use it to make recommendation in the future [4].

A common feature of various adaptive Web systems is the application of user models (also known as profiles) to adapt the systems’ behaviour to individual users. As we mentioned, in order to have an adaptive system we need to know a set(s) of information about the user which will help in deciding the appropriate set of actions. The work by [1] reviewed user models and user modelling approaches applied in adaptive Web systems. The following key questions were investigated: what is being modelled, how it is modelled, and how the models are maintained. The following attributes are some of the attributes used for modelling students in adaptive systems:

- Knowledge,
- Interests,
- Goals,
- Background (stable features) extracted through interviews or tests.
- Individual character represented by user features that define a user as an individual. These features are stable and they are extracted through specially-designed psychological tests. The features could describe personality character (active/passive), cognitive style (holist/serialist), cognitive factors and learning style. Mainly, researchers use cognitive styles and leaning styles to model individual character on adaptive systems.
- Context of user’s work Additional attribute that was described in [5] is navigation abilities.

**User Knowledge Models for Adaptive Hypermedia and Adaptive Educational Systems**

The knowledge model in the system is the concepts or contents to be displayed which could be arranged using variety of setups. The concepts could be represented as nodes and the relation between the concepts could be in the form of edges connecting the nodes. Some of the types of knowledge models identified by [1] are:

- **Scalar modelling /Stereotype knowledge**: Aims to divide users to scalar groups e.g. beginners, intermediate, and expert.
- **Overlay modelling**: to overcome limitations of scalar modelling structural models is used in which the body of domain knowledge can be divided into certain independent fragments.

The use of state charts has been proposed by [6] for modelling of hypertext and web based applications. Transitioning into a state chart diagram, the state of the nodes will change (disable/enable) according to the user’s current location in the diagram. As the user moves from one node to another the state will toggle at some nodes as an effect of the transition. And thus a new current state configuration is obtained. The work in [7] suggests two steps aimed to set a standard and formalize the adaptive system architecture. A reusable adaptive web user interface components was developed. In the user model part the attributes were divided into user profile (page setting preference) and user model (usage data). The information in user model are: users’ knowledge of the topic, users’ preferences, or their past experience.

Adaptive systems differ in their implementation based on the aspects of the design that need to be emphasized and improved in the system. In this work the emphasis is on increasing students’ engagement while learning programming. This was reflected in the design by; firstly, involving the students early on in the implementation of the solution. And secondly, by studying students’ current situation and the aspects that must be provided to achieve better engagement.
To validate the results of the systems that are used in education, measurable criteria must be obtained. The following list containing some of the evaluation metrics used to evaluate ITS [8] and course design [9]:

- Active engagement.
- Adapting the system to users’ needs.
- Immediate feedback.
- Detailed assessment.
- Mastering concepts and – Levelling up.
- Time spent while using the system.
- The statistics about users’ activities.

Engagement is a desirable positive attitude. When positive attitudes are obtained by students, then this could enhance the whole learning experience resulting in spending time in purposeful learning activities. There is a robust correlation between student involvement in a subset of ‘educationally purposive activities’, and positive outcomes of student success and development, including satisfaction, persistence, academic achievement and social engagement [10].

Users’ engagement on using systems is one aspect that defines software usability and users’ feelings when using a particular solution. The measurement of user engagement can be of many forms [11]:

1. Sensory measures (invasive and non-invasive): This type of measures has the risk of users changing their behaviour because of their awareness that they are being observed. In addition when this data is analysed automatically it can be computationally heavy.
2. Usage analytics: These types of measures are easy to process such as time spent on task, navigation, keystrokes, and mouse movements.
3. Quantitative and qualitative surveys: users’ feedback of their experience on using the system.

**Measuring User engagement**

There are several methods for measuring user engagement including: self-reporting methods, physiological approaches and web analytics. Web analytics is measuring attributes about visiting a web site such as [12]:

- Click-through rates.
- Number of page views.
- Time spent on site or dwell time.
- Frequency of return visits (during single or multiple sessions).

Additional web analytics attributes are [13]:

- Time between visits or absence time.
- Number of tasks.
- Reading amount.

In an attempt to improve online distant students’ opportunities, the research in [14] aimed to motivate students to practice the required skills before the practicum by modifying the online course contents. Methods that were used to increase students’ engagement and to improve the learning process were a combination of video-based content delivery and on-going formative peer- and self-assessment. The resulting effect was measured using web analytics and student evaluation survey.

In this work the main objective is to investigate aspects of engagement in programming learning that could help us understand students’ engagement better. Also, engagement attributes were defined that are having great effect in students’ learning by providing adaptive system that would be iteratively modified in response to students’ usage data.

**2 METHODOLOGY**

Prior to the design of the system, a review was performed to identify attributes related to engagement in programming learning. The results were published in [15] and the outcome of this review was incorporated in designing the system. The research method used to achieve the research objective is Design based Science Research (DSR). This is whereby systems are designed, implemented and reiterated as needed after performing the necessary updates [16]. DSR involves working with stakeholders to find rigorous IS/ IT solution to real problems.

A tutoring system called DrSUST was built using DSR method. There are three stages of building this tutoring system. The following figure shows
the model of the system and the steps are discussed below.

![Diagram: The proposed model]

**Figure 1: The proposed model**

1- Collect the course materials: The programming course covers six topics/concepts. For each topic there are related exercises and quizzes. Students can rate, ask questions, comment, and identify mistakes or misconceptions.

2- Use the materials prepared in step 1 to build a customised system that is personalized by a set of students’ attributes. The attributes are divided into static and dynamic attributes. The system should be adaptive to student level and interaction, hence give timely feedback.

3- Collect usage log to enhance the system. Large data can be collected from students interaction with the system including the most downloaded materials, the time spent to read text, and the topics in which the students get the worst results.

Informed by adaptive system methodology, three units should be decided before using DrSUST system namely:

- Domain model - information that represents the knowledge in the system.
- Pedagogical model - handles the actual “tutoring” aspects of the tutoring system, adaptive selection of the materials to be presented to students.
- Student or learner model - used to determine the student’s progress.

### 2.1 The Domain:

The materials for Unit1 can be accessed by any student in addition to all the quizzes regardless of their level.

<table>
<thead>
<tr>
<th>Level</th>
<th>Open materials based on the Level</th>
<th>No access</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>Unit1 – Introduction and program structure+ examples+ Quiz1</td>
<td>L3,L4,L5,L6 All other levels Ex &amp; Q</td>
</tr>
<tr>
<td>L2</td>
<td>Unit2 - Primitive data types and operations + examples+ Quiz2</td>
<td>L4,L5,L6 All other levels Ex &amp; Q</td>
</tr>
<tr>
<td>L3</td>
<td>Unit 3 - Selection statements+ examples+ Quiz3</td>
<td>L1,L5,L6 All other levels Ex &amp; Q</td>
</tr>
<tr>
<td>L4</td>
<td>Unit4 – Loops + examples+ Quiz4</td>
<td>L1,L2,L6 All other levels Ex &amp; Q</td>
</tr>
<tr>
<td>L5</td>
<td>Unit5 – Methods + examples+ Quiz5</td>
<td>L1,L2,L3 All other levels Ex &amp; Q</td>
</tr>
<tr>
<td>L6</td>
<td>Unit6 – Arrays + examples+ Quiz6</td>
<td>L1,L2,L3,L4 All other levels Ex &amp; Q</td>
</tr>
</tbody>
</table>

Students have to go through all the previous units to move to the next unit. The displayed exercises and quizzes accessible to the students are the ones related to the current level. At each particular time a student can advance by one level only or go back to one level only. For example a student in level 2 can also go forward to level 3 or backward to level 1 see Figure 2.

![Diagram: Transition diagram]

**Figure 2: Transition diagram**

### 2.1.1 System’s Requirements

1. Access to adaptive system is done via links validation and manipulation.
2. Student cannot access the different concepts sections by simply typing the link, only his level should allow that access.

3. Access to exercises and quizzes is granted if a student has access to related topic or concept.

4. Applying problem solving was the most important recommendation that was highlighted by most of the students. For that students were allowed to practice programming, submit solutions and get feedback.

5. In addition students also mentioned that they would benefit from seeing several solutions for the same problem. Thus on the system correct solutions were shared for the exercises to other students.

6. Shared exercises solutions can only be viewed by a student if he has unlocked the particular exercise solutions by submitting a serious attempt to solve that particular exercise.

The usage of the system and the support was made optional and no grades were given based on the system usage. From our experience, one of the reasons that we made the system usage optional is that students sometimes feel hesitant to declare that they have internet access and that they can access the system. The reason is that students don’t want tutors to force them to allocate more time on the subject outside of the formal classes and labs.

2.2 Pedagogical model

For all the iterations of the systems, the students were not forced to use the system by their tutors. Adaptive systems are classified as behaviouristic learning methods since the systems’ actions will be decided on the students’ behaviours and responses to the systems. [17]

2.3 Users’ model

Table 2 shows the attributes that could describe the users and they were divided into two categories. Firstly, attributes stored and used as part of the students’ model which will eventually be used for adapting the system. Secondly, attributes that were implemented as a general solution in the design.

Majority of the students use mobile devices for navigating the site. This will lead us to consider minimal design of the site and flexible display.

Table 2 below lists the attributes related to students’ engagement and the way they were implemented in the system.

Table 2: Users' Attributes

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Attribute Adaptive</th>
<th>- Generic Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contents language</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Simplified explanation</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Quizzes with immediate feedback</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Anonymous Assistant</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Controlled navigation vs. free navigation</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Unlocking exercises’ solutions</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Devices used for accessing the system</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Level, Q_level, Ex_level</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Chatting help and support from lecturers and colleagues</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Learning Styles (holist/serialist)</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

The user model is the critical component in this research. Initial modelling of the user had one attribute; additional attributes were added in every iteration and development of a new version of the adaptive system.

1. **Navigation Pointer**: the navigation pointer let student to continue from the last place that was visited.

2. **Reading Level**: initially both reading level and navigation pointer were considered to be identical attributes. But the fact that students revisit previously read concept created a difference. Reading Level does only increment while navigation pointer can increment or decrement.

3. **Preferred language**: Initially the domain knowledge materials were in Arabic language only as the interviewed students mentioned some difficulties in studying in English. And after interviewing more students it has been realized that not all students preferred to study in Arabic. So the preferred language attribute was added as a student attribute that can be altered any time.
4. **Exercises level**: Students who master a concept and perform the necessary exercises will level up in Ex-level and get more difficult exercises.

5. **Quizzes level**: Students who master a concept and perform the necessary quizzes will level up in Q-level and get more difficult quizzes.

6. **Learning Style** (holist/serialist): Some students tend to scan most of the lecture notes as a first round in studying the syllabus before attempting any quizzes or exercises (holist) while others will study and perform additional activities before moving to advanced topics (serialist).

The following section will provide attributes that constitute user’s model or profile on the three iterations of the DrSUST. As a start the student’s level in reading (navigation level) and quizzes levels were used as the initial attributes. Additional attributes were added as a response to the usage of the system.

3 **RESULTS**

In this work an adaptive system was designed and built iteratively to help students in learning programming and to identify the engaging aspects of learning. Additional functionality and improvements were added to the system after each system’s iteration. These were derived from the usage pattern perceived from students’ log data. The following sections provide implementation details and usage patterns for the three iterations of the system development.

3.1 **DrSUST 1.0**

First iteration of the system was launched in the academic year 2015-2016, first semester for first year students (60) studying programming course at SUST. The system was launched on 8 Feb, three weeks before the final exams. Fixed logins were created for all the students.

3.1.1 **DrSUST 1.0 specification and usage data**

The design of this version of the system was as follow:

1- All the teaching materials were in Arabic.

2- Limited navigation was allowed based on the navigation pointer.

The usage data showed that:

1- Only 31% of the invited students tried the system.

2- While students tend to read and attempt quizzes, there are no attempts of solving programming exercises.

3- Some students stayed on a quiz for long duration with no attempts to solve it in several sessions. The causes of no quizzes submission might be because:
   a. In this version of the system students were required to finish a whole quiz before submitting; no immediate feedback on the attempted questions.
   b. Students are writing quiz questions down so that they can solve it with their colleagues.

4- 69% of students did not attempt the exercises, the reason might be because:
   a. Not confident about their programming abilities
   b. No marks was awarded for submissions
   c. The exercises were easy, they have done all sort of practice and quizzes seemed to have challenged them.

5- The system provided material sequencing with a pointer indicating where they reached. Some students tried to access the pages directly by copying links from their colleagues.

6- Some students preferred studying in English while others preferred Arabic.

7- Also, students are interested in having an immediate feedback and help in the attempted quizzes.

3.2 **DrSUST 2.0**

This time students were allowed to create their own logins and senior students were invited to test the system.

3.2.1 **Adaptive Tutor specification and usage data**

The design of this version of the system differs from DrSUST 1.0 in the following:
1- Students were presented with an option of Arabic or English language in order to select their preferred language to learn programming. Hence it will define which part of the system to navigate.

2- The quizzes were divided and submission is done in question base.

3- Students were allowed to skip some questions and try them later.

4- Positive feedback response was received on the questions design.

The outcomes of the usage log data showed that: Still no trial of programming exercises.

Table 3: Summary of visits to DrSUST 2.0

<table>
<thead>
<tr>
<th>St_no</th>
<th>Visits</th>
<th>Duration / min</th>
<th>clicks</th>
<th>Topics, quizzes, exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>112</td>
<td>2</td>
<td>11</td>
<td>43</td>
<td>{6, 0, 0}</td>
</tr>
<tr>
<td>113</td>
<td>1</td>
<td>3</td>
<td>19</td>
<td>{1, 1, 0}</td>
</tr>
<tr>
<td>114 {En + Ar}</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>{2, 0, 0}</td>
</tr>
<tr>
<td>115 {En + Ar}</td>
<td>1</td>
<td>86</td>
<td>20</td>
<td>{5, 0, 0}</td>
</tr>
<tr>
<td>116</td>
<td>1</td>
<td>6</td>
<td>21</td>
<td>{2, 1, 0}</td>
</tr>
<tr>
<td>117</td>
<td>1</td>
<td>7</td>
<td>12</td>
<td>{3, 0, 0}</td>
</tr>
<tr>
<td>118</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>{1, 0, 0}</td>
</tr>
<tr>
<td>119</td>
<td>1</td>
<td>1</td>
<td>16</td>
<td>{2, 2, 0}</td>
</tr>
<tr>
<td>120 {En + Ar} All q2</td>
<td>1</td>
<td>97</td>
<td>180</td>
<td>{8, 1, 0}</td>
</tr>
</tbody>
</table>

This student was the student having the most positive comment: “Beautiful summary! – is that all?”

Table 3 shows student no 120 gave the most positive comments on the system. Although this student was not the one who stayed in the system longer, but he was the user with the higher number of clicks or transition in the system.

There are two terms used here firstly; visits to the system as shown in the above table which denote individual users’ session. And secondly pages visits which is used in the coming table and it shows the frequency of visiting the individual pages. In one session a user can visit multiple pages. Table 4 below gives the count of individual pages visits to each of the concepts.

Table 4: Students’ pages visits counts

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
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<td>1</td>
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</tr>
<tr>
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<tr>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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Table 4 above shows that only 4 students finished visiting all the topics. The log data indicated that students used various approaches to study or navigate the reading materials in the system. Firstly, the students completed visiting all the lecture notes before attempting to solve any question or programming exercise. After completing the first round of reading related materials, the student went back to the beginning to try other activities. Thus restricting the navigation on the web site to one level at a time is not applicable for students who wish to revisit some of the previously studied concepts. Secondly, the students read a particular concept notes and try the corresponding exercises and quizzes immediately before going to advanced levels.

Thirdly, some students visit all the lecture notes regardless of the language. They read the topics in Arabic and later will cover the same topic in English. Which means that student’s preferred language should be a dynamic attribute that changes based on student’s interest at a particular time.

3.3 DrSUST3.0

This version of the system was launched at the beginning of the 2nd semester of the academic year 2016-2017.

3.3.1 Adaptive Tutor specification and usage data

According to the domain model on the first version of the system the student could not access the links directly after passing them with more than one level. For example if a student is at level 3 and he needed access to level one, he/she will not be able to do that directly. They have to return to level 2, and from there to level 1. In the light of the above issue, in the third iteration of the system students were free to visit previous material that they need to revisit as shown in the following figure 3.

In this version of the system there was no difference between reading levels and the navigation pointer. A reading level can only be incremented while navigation pointer can be incremented and decremented. Both students’ activities/ information will be logged or remembered (reading level and the navigation pointer) and used for displaying the appropriate contents.

New Requirements

1. Access to adaptive system is done via links validation and manipulation. The modification in the new version of the system was on revisiting materials. Students can freely navigate backwards if they needed to revisit previously studied materials.
2. Shared exercises solutions can only be viewed by a student if he unlocked the particular exercise solutions by submitting a serious attempt to solve it.

Table 5: Summary of visits to DrSUST 3.0

<table>
<thead>
<tr>
<th>St_no</th>
<th>Visits</th>
<th>Duration / min</th>
<th>clicks</th>
<th>Topics, quizzes, exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>2</td>
<td>4</td>
<td>5</td>
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</tr>
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<td>8</td>
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<td>{1, 0, 0}</td>
</tr>
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<td>9</td>
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<td>1</td>
<td>{1, 1, 0}</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>10</td>
<td>6</td>
<td>{2, 0, 0}</td>
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<td>14</td>
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<td>2</td>
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<td>{1, 0, 0}</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>26</td>
<td>96</td>
<td>{3, 1, 0}</td>
</tr>
</tbody>
</table>
This student was the only student who submitted exercises.

4 CONCLUSION

Adaptive systems differ in their implementation based on the aspects of the design that need to be emphasized and improved. In this work the emphasis was on increasing students’ engagement while learning programming. This was reflected in the design by involving the students early on in the implementation of the solution, studying their current situation and the aspects that they needed to be provided to achieve better engagement. There were three iterations in developing this technical solution. Attributes that represents students' needs and personalized systems survey and attributes that can increase engagement were identified. In building the system students’ engagement attributes were divided to generic attributes which were used as guidelines when implementing the system and attributes that are part of the students’ model i.e. personalized attributes. Generic attributes are attributes that effect the general design of the system i.e.: Simplified explanation, Quizzes with immediate feedback, Anonymous Assistant, Devices used for accessing the system and Chatting help and support from lecturers and colleagues. The personalized attributes are attributes that represents features of individual students and they were: Contents language, Controlled navigation vs. free navigation, Unlocking exercises’ solutions, Level, Q_level, Ex_level, and Learning Styles (holist/serialist). The attributes that reflect students’ engagement were: making comments, click rates, overall coverage of materials and the duration in using the system.

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Digital Technologies and Digital Strategies to Enhance Musical Knowledge: A Qualitative Case Study

Michele Della Ventura
Music Academy “Studio Musica” – Department of Music Technology
Via Andrea Gritti, 25 – 31100 Treviso Italy
dellaventura.michele@tin.it

ABSTRACT

This article provides an overview of the role that the on-line platform OPEN SoundS can play in promoting musical education in a classroom with dyslexic students. The platform is a musical environment designed and developed as a virtual studio where students and teachers can create collaborative musical projects. In this on-line environments, the users deal with technologies for music processing, research, and communication that can help to develop personal skills and to enhance learning and teaching. The purpose of this study is to identify implications for future studies in the use of digital technology for learning. Results showed that students with dyslexia compensated for their processing deficits by relying on learning strategies.

KEYWORDS

Dyslexia, learning motivation, music education, student performance, technology enhanced learning

1 INTRODUCTION

Pondering on the current state of the relationship between the internet and the educational disciplines calls for a statement of fact: the diffusion of internet usage is an already acknowledged fact which can no longer be understood as a marginal phenomenon and which appears to be susceptible of important growth and developments [1][2]. We may, in other words, interpret it as a relevant aspect of a new "normality" [1] which is progressively establishing itself and tends to position those who think it possible to stay offline in a marginal area [3], imposing on them serious penalties at the level of information, communication and updating [4]. Internet represents an important tool for the didactic, enhancing the learning process: with Internet it is possible to speak of e-learning. E-learning is a platform with flexible learning using Information and Communication Technology (ICT) resources, tools and applications, and focusing on interactions among teachers, learners and online environment [5]. The learning environment must be a “smart learning environment”: “technology-supported learning environment that can make adaptations and provide appropriate support in the right places and at the right time based on individual learners’ needs, which might be determined via analyzing their learning behaviours, performance and the online and real-world contexts in which they are situated” [6][7]. Digital technology can improve the learning process but if used appropriately, it also represents a dynamic, forceful and useful tool for teachers because it can enhance their teaching process. If teachers use digital technology to enhance learning and teaching, they can also help students to improve their educational outcomes.

Nowadays, there are a lot of learning platform for different subjects, but there is little attention for the musical field.

This paper presents a case study conducted in a Music High School using the learning-environment OPEN Sounds (OS) in order to improve the performance of students in the area of theory, analysis and composition. The
main aim of this project was to analyze the impact of the use of OS in the students' learning process: increase the student's motivation in order to see if it corresponds to an improvement of his/her academic results. Moreover, this project took the students' learning styles into consideration, in order to meet the needs of all students: non dyslexic and dyslexic students.

This paper is organized as follows. Section 2 describes the learning style and teaching style. Section 3 describes the motivation to learning. Section 4 describes the computer environment OPEN SoundS. Section 5 shows an experimental test that illustrate the effectiveness of the proposed method and finally, conclusions are drawn in Section 6.

2 LEARNING STYLE AND TEACHING STYLE

Learning style means "one person's preferred approach to learning, his/her typical and stable way of perceiving, processing, storing and recovering information" [8]. Knowledge of the students' main learning and cognitive styles and the reflection on their own personal characteristics, of their own teaching method, constitute an important element among the assets of a good teacher. Only by taking into account the individual differences could the teaching method be sensitive to the ways in which the student learns, take advantage of his/her inclinations and adapt them to contexts and situations where such inclinations might cause difficulties [9] [10].

Students learn in different manners in accordance with the modalities and strategies that every one of them uses to process information, starting from the sensory channels that allow us to perceive the stimuli coming from the external environment: verbal, iconographic, auditory and kinesthetic channel [8]. Thus, only if the teacher takes into consideration the students' learning style - by favoring the use of strategies that are more suitable for them - does he facilitate the achievement of the educational and didactic goals.

While the construction of the teaching activity, based on a certain learning style, actually favors all the students, instead, in case of a dyslexic student, referring to the learning styles and the various strategies that characterize him/her, during the educational procedure, becomes vital for achieving success at school.

The teacher must, therefore, deal with the problem related to the "class" concept seen as a set of students having heterogeneous learning styles. The presence of dyslexic students imposes on the teacher certain didactic choices that help such students and that also turn out to be useful for all the other students (the non-dyslexic ones) [11] as well in order to make didactic practice more efficient, the study method more conscious and the learning more long lasting and more profound.

The teaching strategies used by the teacher may be different, but at the same time useful for all the students in general [12]. A thorough planning of the learning process may use strategies that are useful, at the same time, for all the students (dyslexic or not):

- the use of simple and clear language during the explanations, with terms that are repeated and refer to the written text (adopted handbook);
- the use of images, diagrams and conceptual maps that refer to the iconic aspects of the written text;
- the definition of the lesson on the macro-structure level, on which to build afterwards the explanation of every single concept and the relationships with other concepts.

The strategies must, however, be accompanied by a series of indicators (see Table 1) that the teacher has to take into account so as to do an ongoing evaluation of the learning process. The choice of such indicators is determined by certain criteria:

- the importance and significance assigned to the indicators (i.e. to the aspects
described by them) by the parties involved in the project/intervention;
- the facility and reliability of survey of the indicators in the evaluation to be carried out;
- the power of synthesis by means of which they express complex phenomena and summarize their evolution in time;
- the causal relationship between the indicator and the set of predefined objectives.

### Indicators referred to the internal process
- The students need clear and complete instructions and indications
- The student asks for information and clarifications during the explanation
- The student asks for a summary of the explained concepts
- The student associates images to the concepts

### Indicators referred to the learning and growth process
- The student associates different concepts
- The student easily expresses his/her own ideas
- The student takes notes and highlights the most difficult concepts
- The student intervenes during the explanation
- The student explains in his/her own words the concept so as to achieve certainty with respect to his/her learning
- The student makes connections to concepts that have been already explained
- The student applies already-used strategies in similar contexts
- The student autonomously extrapolates solutions adaptable to other contexts
- The student looks for alternative paths to the solution of a problem

**Table 1.** Indicators for the evaluation of the teaching strategies.

The development of strategies precedes the motivational development, in that the capacity to strategically deal with the learning situations leads to positive results, which lie at the heart of motivation.

## 3 MOTIVATION TO LEARN

Motivation is defined by psychologists as an internal process that activates, guides, and maintains behavior over time [12]. In other words motivation gets you going, keeps you going, and determines where you’re trying to go [13]. Motivation influences learners to choose a task, get energized about it, and persist until they accomplish it successfully, regardless of whether it brings an immediate reward. Motivation is present when learners actively seek out and participate in activities without having to be rewarded by materials or activities outside the learning task.

Emotions have an effect on learning and achievement, mediated by attention, self-regulation and motivation [14]. Therefore, emotion represents an indicator of the motivation: emotion is related to motivation in such a way that human beings tend to execute things that we hope would lead to happiness, satisfaction and any other positive emotion at some degree [15].

Motivation represents an important factor when the teacher has to deal with the concept of "classroom" intended as a group of students having heterogeneous learning styles. The presence of dyslexic students imposes on the teacher certain didactic choices that help such students and that also turn out to be useful for all the other students (the non-dyslexic ones) in order to make didactic practice more efficient, the study method more conscious and the learning more long lasting and more profound [16].

Dyslexia is defined as a **Specific Learning Disorder (SLD):** it is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities [17][18]. Dyslexic students can write and read, but they manage to do so using their capacities and energies at the maximum, given that they cannot do it automatically. They grow tired quickly, they make errors, fall behind, do not learn [19].
One of the major issues of the individuals affected by SLD is the lack of autonomy in the learning process, which leads the individuals to disesteem (emotion) and educational failure [17] (weaknesses), therefore to a lack of motivation.

To ensure that all students have the possibility to develop a wide range of musical skills, teacher must take into consideration the different learning styles of the students and leads them during the learning process.

Based on what has been said above, it becomes obvious that teaching and learning go beyond the content: students learn because someone teaches and helps to learn.

4 OPEN SOUNDS

OPEN SoundS is an on-line platform that offers a new dimension in training on the Net: the possibility to produce and share music remotely within communities.

OPEN SoundS’s working dimension and project are a virtual environment designed for creative expression mediated by the use of dedicated technology and by the peer communities set up to develop more proficient learning processes through music production teamwork.

In other words: a virtual environment and strategic model to teach how to approach and access the digital world, its tools, practices, codes, alongside a conscious use of them when learning.

With OS students can collaborate in groups, talking freely to one another. Discussion helps with the understanding of what they are doing and why [20] (i.e. the use of a stylistic feature instead of one another, the use of a cadence). More able learners develop their communication skills by clarifying their ideas as they explain them to others. Less able students are usually supported by other group members, and feel more confident (emotion) to contribute ideas [21].

OS is a learning environment where students and teachers can create collaborative musical projects (in a formal and informal way). They can create a project, describing it in every aspect, uploading music files, reading the contribution of each student and writing/reading comments about the creative productions.

The creation of a music project through a teamwork permits the acquisition and development of musical skills and a progressive awareness of the musical grammar rules.

In this new learning context an important role is played by the operations of monitoring and analysis essential for the development of a quality learning process. In this context emerge the necessity to ponder on the relationship that the technologies have with didactics so as to monitor and analyse both the changes in the learning habits and styles of the students [22].

Therefore, it is necessary to define some learning indicators (table 2) that can help the teacher to assess the process especially when the are dyslexic students in the group class.

<table>
<thead>
<tr>
<th>Indicators referred to the internal process</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Use of informal language to seek dialogue</td>
</tr>
<tr>
<td>• Comforts self by seeking out special object or person (emotion)</td>
</tr>
<tr>
<td>• Seek a preferred friend</td>
</tr>
<tr>
<td>• Acceptance of redirection/advises from other users (emotion)</td>
</tr>
<tr>
<td>• Indication of needs and wants</td>
</tr>
<tr>
<td>• Recognition that others’ thinking in a different way</td>
</tr>
<tr>
<td>• Ability to cooperate with the group members</td>
</tr>
<tr>
<td>• Ability to encourage the group members to participate in the dialogue</td>
</tr>
<tr>
<td>• Use acceptable language and musical grammar rule rules during communication with others</td>
</tr>
<tr>
<td>• Use successful strategies to solve a problem</td>
</tr>
<tr>
<td>• Sustain interest in working on a task, especially when people offer suggestions, questions, and comments</td>
</tr>
<tr>
<td>• Cooperate and shares ideas and materials</td>
</tr>
<tr>
<td>• Seek help to resolve problems</td>
</tr>
<tr>
<td>• Suggest solutions to a problem</td>
</tr>
<tr>
<td>• Show interest in the speech of others</td>
</tr>
<tr>
<td>• Respond appropriately to specific</td>
</tr>
</tbody>
</table>
5 APPLICATION AND ANALYSIS

The method proposed in this article consists in the use of the computer environment OPEN SoundS in order to improve the performance of students in the area of theory, analysis and composition.

In this regard, the main aims of the project were:

- to promote the development of key competences;
- to encourage the ability to share the common construction of knowledge and project-making processes;
- to use a new method to teach and learn through the formal and informal system of knowledge access and construction;
- to foster the meaning fullness and value of the emotional aspects that are the key to active participation in virtual workgroup;
- to encourage student engagement in study, enhancing self-awareness and motivation.

The research was conducted for a time period of eight months (from October 2016 to May 2017) and it involved the fourth grade of the Music High School, with a total of 18 students: 14 girls and 4 boys of which 2 affected by dyslexia.

In the first three months of work the students participated in the lessons in the classroom listening to the explanations of the teacher, taking notes and studying on the book adopted by the teacher. At the end of every month, an examination was passed in the classroom (identical for non-dyslexic and dyslexic students) taking note of the students’ mistakes.

Table 3 shows the list of the recurring mistakes and the number of students who made them in the first period (from October to December 2016).

<table>
<thead>
<tr>
<th>Mistake</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fifth relation</td>
<td>8</td>
</tr>
<tr>
<td>Eighth relation</td>
<td>7</td>
</tr>
<tr>
<td>Progression of fifths</td>
<td>8</td>
</tr>
<tr>
<td>Progression of eighths</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 2. Indicators to evaluate the (in-itinere) learning process.
Augmented interval 9
Incorrect use of stylistic features 11
Incorrect realization of a cadence 7
Incorrect realization of a progression of chords 10
Incorrect realization of a Musical Pedal 11

Table 3. List of the students’ mistakes (1st period).

In the following months, students were allowed to use OS to study all together, making different exercises proposed by the teacher where it was possible to apply the musical grammar rules related to mistakes of table 2.

At the end of the project (on May 2017) another examination was passed in the classroom and the result were very satisfactory (see table 4 and figure 1).

<table>
<thead>
<tr>
<th>Mistake</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fifth relation</td>
<td>3</td>
</tr>
<tr>
<td>Eighth relation</td>
<td>3</td>
</tr>
<tr>
<td>Progression of fifths</td>
<td>4</td>
</tr>
<tr>
<td>Progression of eighths</td>
<td>2</td>
</tr>
<tr>
<td>Augmented interval</td>
<td>3</td>
</tr>
<tr>
<td>Incorrect use of stylistic features</td>
<td>2</td>
</tr>
<tr>
<td>Incorrect realization of a cadence</td>
<td>1</td>
</tr>
<tr>
<td>Incorrect realization of a progression of chords</td>
<td>1</td>
</tr>
<tr>
<td>Incorrect realization of a Musical Pedal</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 4. List of the students’ mistakes (2nd period).

There was a substantial improvement, as far as the two dyslexic students are concerned, to the point of managing to pass the final examination with a mark higher than 60%, considering that it was not (as already mentioned) different from the test of the other colleagues. The learning improvement also appeared for students who already drew a high profit: the process was positive for them as well, inasmuch as they learned to select the information they found based on the group members (particularly with reference to the dyslexic students).

The method has shown that: firstly, the situational interest which was encouraged in students by mere novelties; secondly, individual interest (selecting ideas, composing music) as well as self-regulation and independent learning were well expressed throughout the entire period of research: students also liked the fact that learning was simple and that they were successful in learning.

From the notes of teachers’ reflections we found out that there was a positive productive students’ motivation which was expressed in their selection of more demanding tasks and in their perseverance in improving achievements and their desire to put in place new musical ideas.

6 DISCUSSION AND CONCLUSIONS

With the increased availability of on-line technologies and computers software, teachers and students may be able to change the manner to teach and to learn. Emotions play a critical role in the teaching and learning process because learners’ feelings affect motivation, self-regulation and academic achievement.

Didactics is mainly concerned with proposing, setting up, managing "learning environments", in other words particular contexts that are furnished with specific devices deemed capable of favoring knowledge acquisition processes.
The introduction of OPEN SoundS was truly satisfying: there was a positive and significant impact both on the learning and on the teaching which was subsequently mirrored by the results reached at a didactic level. The participants were very highly motivated to learn using OPEN SoundS. Therefore, the principle affordance of OPEN SoundS was that it provided an arena for active, critical learning about non dyslexic and dyslexic students. The students’ approach to learning was profoundly social and collaborative.

These perspectives may be drivers for developing didactics responsive to complex and technology-rich learning environments, and where the learning object is not just given but jointly constructed.

Teachers can make the best use of technology in the classroom by developing their awareness of a range of digital technologies and considering carefully both how and why they can be used to support students’ learning.

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Container-based Virtual Environment for Battle Execution of Round-robin in Applied Java Programming Exercise with Game Strategy and Contest Style

Naoki Hanakawa and Hiroyuki Tominaga
Kagawa University
2217-20, Hayashi-machi, Takamatsu City, Kagawa Pref., Japan
s16g464@stu.kagawa-u.ac.jp, tominaga@eng.kagawa-u.ac.jp

ABSTRACT

We have proposed an applied Java programming exercise with board-game strategy for learning problem solving. During the implementation of Gogo game methods, students learn concepts such as algorithms and revision using trial and error by execution results. We have developed the support system “WinG”. WinG-LA is a local review tool. It offers a game execution library as Java API’s, and contains four modules for examination of strategies. WinG-CS is a contest management server. It executes many games among the students' uploaded programs and maintains the preliminary and final periods for the battle league. Students’ scores are decided by the result of round-robin matching. We performed an educational practice in 2011. In this paper, we describe the improvement of WinG-CS and exercise practice, and introduce a virtual environment into the server for efficiency. We reconfigure the database. We also propose a program execution platform using container based virtual environment. This realizes inexpensive, easy, and suitable load distribution for the educational site.

KEYWORDS

Java programming exercise, board game strategy, continuous integration, round-robin contest style, rating index by standing, virtual environment

1 INTRODUCTION

1.1 The ultimate goal of programming education

In information engineering colleges, programming exercises are regarded as a required subject. After an introductory exercise in a junior class, an advanced exercise in a senior class considers object-oriented programming with C++/Java languages.

We consider that two aspects of the process and product are important toward the ultimate goal of programming education. One is the algorithmic approach, which refers to programming skills regarded as an effective tool for problem solving. The other is the desirable attitude of an engineer. This means continuous integration of programming according to software development methods. However, if the subjects of the field are far from the student's interest, it is difficult to illustrate concrete images and pursue the goal of programming. Moreover, without interest, a student does not feel any attachment to a software product that he creates and must maintain.

A teacher often selects applied problems related to specific IT fields. He also treats simple projects on information systems based on actual works. However, a student often does not understand the requisite mathematical concepts, or does not understand a concrete image because of a lack of social experience. Therefore, he tends to stumble on a clue of the problem condition, and gives up solving by programming.

1.2 Programming exercise of game strategy with a contest style

In the field of knowledge information processing, game strategy programming is an attractive exercise subject. It includes several learning items, such as formulation of move operation, condition of application, pattern matching of the board situation, intellectual searching by forecast, and simulation trial.

It includes the competitive learning approach, adopting a contest style between students’ strategies. A student considers this work a voluntary attempt rather than a teacher's imperative task. The approach is expected to improve motivation and to bring about educational effects. Moreover, the best
strategy, which is considered the most correct answer, is not clear. Thus, learners are required to continuously integrate new information through competitions with opponents.

2 OUTLINE OF OUR EXERCISE

2.1 Applied Java exercise of board game strategy

We have proposed an applied programming exercise in board game strategy using a contest style. We adopt the board game "Gogo," which is a variant of "Ninuki-Renju," like "Pente." We have developed the support system “WinG” [1][2]. We have carried out several educational practices since 2005 in an applied programming lesson. This exercise became a required subject, and was positioned as a more serious problem in 2011.

2.2 Rules and features of board game Gogo

Japanese traditional Gobang (Gomoku-Narabe) is a very famous board game, and is a simplified version of "Renju." Each player alternately puts a stone with his color (white or black) in a square mesh board. The player aims to create a connected run with his five stones in a straight or diagonal line. "Ninuki-Renju" is not so popular, but is a very interesting game based on Gomoku. It has additional rules about removing and capturing the sandwiched opponent's stones. "Pente" is known as a variant of the game in Germany and Poland [3]. We adopt "Gogo," which is also a simple version of Ninuki-Renju. The board has 169 cells in a 13×13 square. We adopt an arrangement of the rules for a reasonable subject of the programming exercise (Fig. 1). There are two winning conditions: creating a "steady" five-run or capturing five pairs (ten stones). As an "unsteady" five-run has removable pairs, the run can be broken in the next turn, and the game does not end. Moreover, if the fifth pair is obtained in that situation, victory can be achieved out of a disadvantage. Runs greater than five are not applied in the winning condition. Making two three-runs (San-San) by placing a stone is a mismove and a losing condition, whereas making San-San by removing a pair is allowed.

Gogo is profound in that removing stones causes a significant change in the board situation, and surprising turnover of a game aspect. When forming a strategy, two aspects must be considered. One is the tendency to aim for connecting or capturing, and the other is a tendency to choose attack or defense. The policy of strategy has many variations with various evaluation functions. Though the rules are simple, a beginner shows his individuality with the preference and attitude. As documents about rotes of Ninuki-Renju are not enough, you must search good strategies by yourself.

2.3 Previous system and our research

We developed the first version of WinG in 2005. It consisted of a local execution environment and contest-management server WinG-CS [1]. The environment offers game execution between strategies or human players, and battle record functions for review. By doing this, we support the students’ creation of strategies. With the initial edition of WinG-CS, we devised a mechanism by which students submit strategies and execute them on the server.

The environment changes in a local development tool WinG-LA as the next version [2]. WinG-LA consists of 4 modules: "game execution," "battle record replay," "board situation generation," and "hand trial test." We introduced SWG and the first version of WWG (weighted winning grade), which is a simple rating index [4].

2.4 Making process of the strategy program

We offer a board game execution library for Gogo as a Java API. The hand method calc_hand() is overridden in the subclass inheriting the Computer Player class by student. The method receives the current state as an argument. It returns the next hand. The state, as an instance of the State class, consists of the board situation for stone placement and two pockets for captured stones. An instance of
the Master class manages the game progress according to the rules. We present a strategy prototype to students, which includes the necessary processing as comments. Most strategy codes have 300–500 lines.

The overview of the strategy design in Gogo is shown in Fig. 2. In the first step, the outline of a strategy idea is considered, and a tactics policy is determined. Each tactic is mostly described by if-then rules in terms of knowledge and information processing. In the second step, the left-hand side of a rule is pattern recognition of the stone placement on the board. Various matching algorithms of stone placement are realized, such as a four-run, double runs, and multiple capturing. More detailed patterns may be refined, and specific patterns may be determined for the winning process. The right-hand side is the assignment of an evaluation value for each cell by a heuristic function. Table 1 shows examples of production rules. The evaluation value must be revised by trial and error through game execution. Students consider the global board situation and an adjustment of the priority of the rules. In the last step, a cell with the maximum value is selected as the hand. These steps are repeated to continually improve the strategy.

Not only does pattern matching improve, but forecast reading is also adopted in the game-tree search. If the strategy is used, strategy evaluation must be used, such as $\alpha$-$\beta$ pruning. Students may also introduce strategies based on probability, like the Monte-Carlo Tree Search, as a more advanced challenge. However, in such complex strategies, they need to consider the time limit per hand and make the appropriate pruning steps.

### 2.5 Progress support of strategy programming by WinG-LA

The local review package WinG-LA offers several functions for the examination of strategy and debugging. It consists of four modules, as shown in Fig. 3. They are implemented as a Java standalone application. The package also contains a reference manual for the game execution library and contest rules.

The strategy execution module performs a battle between computer players with implemented strategies as the execution environment (Fig. 4a). The record replay module exhibits a game by a battle record for strategy analysis (Fig. 4b). The state edit module makes initial game states for test cases of hand debugging (Fig. 4c). The hand trial module shows results of some board state with one hand operation by a strategy program as a simple test (Fig. 4d). To aid in strategy consideration, WinG-LA also prepares many samples of game strategies, initial states, and battle records.

### 2.6 Preliminary and final league in game contest

In our exercise, we have set a tournament period of several weeks. We also carry out a preliminary league and a final league in a battle style. Learners can submit their strategy many times during about five weeks in the preliminary league. The submitted strategy competes with other strategies on the contest management server. The battle result is given by weight winning grade considering rating of each strategies. In the preliminary league, the server receives ~1000 submissions from 40 learners. This means that the server performs hundreds of thousands of battles in a round-robin battle, which requires a long execution time. Therefore, we introduce a thinning round-robin battle in consideration of a winning degree.

The contest management server WinG-CS publishes all battle results and the rankings of the submitted strategies. Learners can check steps and the cause of victory in their battle results, and replay battle records while excluding the opponent strategy codes. We introduce index strategies in three strength levels as the strength index. This information is effective feedback for revising strategies. In this way, we motivate the learners to revise their own program continuously by providing the opportunity to constantly evaluate their own strategies.

After finished preliminary league, students comprehensively judge and select their own best strategy, which will participate in the final league. In the final league, the server performs a round-robin battle with the strategies provided. An evaluation of each student is
decided by the score and a summary report, in which he/she analyzes the process and result.

![Figure 1. The rules of Gogo and board states](image)

Figure 1. The rules of Gogo and board states

![Figure 2. The overview of strategy design in Gogo](image)

Figure 2. The overview of strategy design in Gogo

<table>
<thead>
<tr>
<th>Pattern</th>
<th>A/D</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Destroy: 5-run</td>
<td>Run</td>
<td>Defense 1000</td>
</tr>
<tr>
<td>Realize: 5-pairs</td>
<td>Pair</td>
<td>Attack 950</td>
</tr>
<tr>
<td>Realize: 5-run</td>
<td>Run</td>
<td>Attack 900</td>
</tr>
<tr>
<td>Block: 5-pairs</td>
<td>Pair</td>
<td>Defense 900</td>
</tr>
<tr>
<td>Block: 5-run</td>
<td>Run</td>
<td>Defense 850</td>
</tr>
<tr>
<td>Attack: 4-run</td>
<td>Run</td>
<td>Attack 800</td>
</tr>
<tr>
<td>Block: 3-run</td>
<td>Run</td>
<td>Defense 700</td>
</tr>
<tr>
<td>Attack: 1-pair</td>
<td>Pair</td>
<td>Attack 300</td>
</tr>
<tr>
<td>Mismove</td>
<td>-</td>
<td>-1</td>
</tr>
<tr>
<td>Others</td>
<td>-</td>
<td>Rand</td>
</tr>
</tbody>
</table>

Table 1. Examples of production rule

![Figure 3. The module configuration in WinG-LA](image)

Figure 3. The module configuration in WinG-LA

![Figure 4. GUI of the 4 modules in WinG-LA](image)

Figure 4. GUI of the 4 modules in WinG-LA
3 Purpose and position of our exercise

3.1 Game strategy programming exercises in our curriculum

We carried out this exercise in an experiment for the third-year students in an information and electronics engineering college. Students had already studied data structures and algorithms in C and the basic syntax of Java in another class. We have also carried out an exercise with card game strategy in C [5]. Its subject matter is a poker game. The students aim for high points, and they are ranked by points. They learn the design of data structures, such as decks and hands, implementation of pattern matching based on a production rule, and the judgement of poker hands. After completing the poker exercise, we started this exercise.

We described the differences between the card game and board game exercises. These exercises complement each other. In the card game, we used incomplete information game. In addition, the card game exercise used scoring, rather than competition. Thus, the students’ efforts directly lead to results. In contrast, in this exercise, we use a game with perfect information, and this exercise is in a battle style. Therefore, it is difficult for students to improve results only by their own efforts.

3.2 Learning items and educational purpose

Our educational goals in this exercise consist of two aspects: analysis and design, and implementation and verification. On analysis and design, we make the students examine the application conditions of the hand and priority of processing based on search algorithms in knowledge engineering. Such tasks include formulating the hand application condition, extracting the pattern of a characteristic state participating in a win or lose condition, such as San-San, and implementing heuristic knowledge obtained from actual experience.

On implementation and verification, we require the students to practice the spiral development method based on object-oriented programming. In other words, we stimulate the students to improve their evaluations of states or hands from the battle result. This includes steps such as localizing points to fix the evaluation parameters using modularization, verifying the validity of method of hand using the sample state as a test case, and improving the state analysis by replaying battle records.

3.3 Related works

Here, we describe related competitions. IPSJ have held SamurAI Coding, which is a game AI programming contest, since 2012 [6]. IEEE CIG holds many game AI competitions annually [7]. MIT has also held Battlencode, which is a battle game AI contest [8]. In general corporations, CodinGame has held the CodinGame Contest, which is an open competition [9]. The purpose is the enhancement of programming skills through the creation of game AI. Thus, many strategy programming contests are held worldwide.

There are also related researches on education applications. Canada aims to improve student knowledge about AI through an international online contest [10]. They verified the educational efforts of participating in the Google AI Challenge as part of the class. It improved motivation and results by using contests in the class. Yoon teaches basic concepts about games and AI using Angry Birds [11]. Other researchers provide practice classes using computer games with the contest style [12][13]. In our research, the purpose is not only creating strong strategy, but also learning appropriate techniques and good practices in software development. This is the most distinct aspect of our research.

In recent years, the development of game AI by machine learning is remarkable. In Go, DeepMind’s AlphaGo broke the world’s top talent for the first time using deep reinforcement learning [14]. AlphaGo Zero, using reinforcement learning through only self-games, is showing a higher Elo rating than AlphaGo [15]. Open distribution of libraries for machine learning, including TensorFlow and Chainer, is also increasing [16][17]. Now, this exercise targets examination and realization of classical strategy. In the future, we would like to respond to such advanced approaches.
4 SUMMARY OF CONTEST MANAGEMENT SERVER WinG-CS

4.1 Support system WinG and execution environment

To realize the exercise, we have developed the support environment WinG (Fig. 5). Learners download WinG-LA, which is a support tool for developing strategies, from a shared folder on our server. They implement their strategies on their own PC. We offer a game execution library as Java APIs, and students use the development environment of their choice. WinG-LA provides some modules, such as battle execution and efficient debugging. It also provides some samples strategies and board situations for examination of their strategies. Server-side WinG-CS, which supports contest management, manages some processes on the server side in the preliminary and final leagues. A league corresponds to each exercise in each year. The system makes the submitted strategies meet in a battle game, and publishes the battle results and records (Fig. 6). The system saves the battle results and records to a database on the server. Learners can browse these data. They can also download battle records, and replay the battles on WinG-LA.

4.2 Functions and configuration of WinG-CS

In this paper, we describe features and enhancement of WinG-CS in 2016 CS. From 2011 to 2015, we had carried out educational practices with previous version of WinG-CS. The system was implemented in Ruby 1.9, and the database is saved by XML. New WinG-CS, which was enhanced in 2016, is implemented in Ruby 2.3 and Ruby on Rails 4.2. Rails is based on a Model-View-Controller architecture, which allows us to reduce the development cost in coordination with the database and GUI. Our contest server mounts an Intel Core i7 CPU and DDR3 32GB RAM. The server OS is Linux series CentOS 6.8, but we updated the Linux kernel to 3.10 to use the virtual environment Docker.

4.3 Internal processing of WinG-CS

WinG-CS accepts the source codes of learners' strategies during the preliminary league. WinG-CS performs acceptance and battle processing as internal processing at all such times. Acceptance processing and battle processing proceed seamlessly after submission. Acceptance processing performs a static check of the synchronous processing and a dynamic check of the asynchronous processing. WinG-CS registers the submission file to the submission DB, and also registers the acceptance result. In the static check, the system checks the file type and file size, and compiles the submission file (Fig. 7). When the learner submits a binary file or a potentially malicious file, the system excludes this file. Dangerous files include some functions, such as OS command execution or input from the keyboard. The students are notified of the result of the static check is notified regardless of success or failure. In the dynamic check, the system performs a checking battle to test compiled strategy binary by a battle with a sample strategy. The system excludes some strategies, such as stopping by error or causing an endless loop. If checking battle finishes successfully, it registers the strategy DB as a strategy which can participate in the preliminary league. Subsequently, in battle processing, the submission strategy performs battles with all submitted strategies and is calculated the weighted winning grade (WWG) (Fig. 8). First, the system obtains strategies in the league, and creates a tournament chart with them. Next, the system performs battles by the tournament chart. During this time, the battle results and game records are saved as temporary files. After finishing battles, it registers the opponent ID and battle result to the battle DB. The game records are XML files, so the system saves a file path to the battle DB. Then, it calculates a temporary WWG using the battle results.

4.4 Introduction of time of suspension of submission

Battle processing takes a considerable amount of time as the number of submissions increases.
In addition, the WWG is affected by the WWG of other strategies, which it also affects. Therefore, processing becomes complicated with successive submission of strategies. WWG also changes frequently. All of this sometimes results in system faults or significant delays in processing on the legacy system. For the reason, we deal with a thinning round-robin series to reduce the amount of processing.

In 2016, we decided to stop strategy submission from 24:00 to 6:00. During this period, we finish the battle processing for the day. The system calculates the battle results and WWG at that time. These results are reflected in the ranking table, and published to the Web in the morning. In the new system, battle processing and database management were improved, so system faults and significant delays no longer occurred. However, there is still room for improvement in the immediacy of result reflections.

4.5 Reconstitution of database

In the legacy system, we use XML as the database. However, when the system registers the battle results of about 1000 strategies, it takes a long time to load from database. We therefore reconstitute the database using RDBMS (Relational database management system) to accelerate. We use PostgreSQL 9.6 as the DBMS (Database management system). Table 2 shows a list of tables that comprise the database. The submission table "Submission" registers all the submitted files. It is a submission management log for the learners. The strategy table "Strategy" registers only strategies which pass acceptance processing and participate in the preliminary league. ID is given to each strategy with a serial number for each learner. It is used to make the tournament chart. The battle result table “Battle” saves all the actual battles. It registers the self and opponent IDs, battle result, and path of the battle record file. Battle record files are still in XML format for use in the record replay module in WinG-LA. In the future, we will consider migrating to saving these files in JSON format.

4.6 Use of Docker in battle environment

We describe using Docker on WinG-CS. On WinG-CS, we register the Docker image as a template of the execution container in advance [18][19]. This image includes openJDK, and contains an execution library and commands. In executions of individual battles, WinG-CS creates an execution container based on the image. The execution container includes the tournament chart (Fig. 9).

Furthermore, the execution container mounts strategy-saving directories and game record directories on the host machine. As a result, we can directly read and write data on the host machine from container. First, the container begins battle processing according to the execution commands. After the battles, the container transfers all battle records to the host machine, and any databases are updated. Finally, the container is discarded. Such an approach also facilitates load balancing using multiple machines.

4.7 Improvement of GUI in the student side

We describe the GUI of the improved system. The top page of the league shows tables of strategy ranking and individual submission history by tab. Learners can remain anonymous by using player nicknames. The general ranking table in Fig. 10a shows the ranking of all submitted strategies so far. Rows of index strategies and their own strategies are shown in different colors, and are emphasized from other learner’s strategies. The submission history tab in Fig. 10b shows only the student’s own strategies. Submitted files are shown in a time series. If the user clicks a strategy name, they move to the strategy detail page. The strategy detail page shows detailed information about the individual strategy in various tabs. The strategy summary tab in Fig. 10c shows conventional information, such as the submission date, battle result information, and strategy code. Learners select their own best strategy for the final league. The records list tab shows all the results of the strategy. Learners can download battle records, and replay them on WinG-LA. They can also download all battle records at once.
Table 2. Database tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>Student ID, Login information</td>
</tr>
<tr>
<td>League</td>
<td>Subject’s name, Contest period</td>
</tr>
<tr>
<td>Player</td>
<td>Player name, Role, Best strategy ID</td>
</tr>
<tr>
<td>Submission</td>
<td>Strategy name, Check status</td>
</tr>
<tr>
<td>Strategy</td>
<td>Submission ID, WWG, File path</td>
</tr>
<tr>
<td>Battle</td>
<td>Strategy ID, Battle result, File path</td>
</tr>
</tbody>
</table>

Contest management server WinG-CS

Install  Download  Upload

Local support system WinG-LA

User strategy (as source code)

Figure 5. Architectures of support system WinG

Figure 6. Functions of WinG-CS

Figure 7. Flow of acceptance processing

Figure 8. Flow of battle processing

Figure 9. Structure of execution environment in Docker container

(a) Total ranking tab

(b) Submission log tab

(c) Strategy summary tab

Figure 10. GUI of student side
5 IMPROVEMENT OF RATING INDEX WWG

5.1 Competition method and winning point

In this exercise, a match consists of two game sets, with players taking turns to go first and second for fairness. A player is given winning points by winning or losing. Table 3 shows the winning point (WP). If the result of two sets is one win and one loss, the outcome is decided on points based on the sum of captured stones. By WP, we can simply subdivide results which were judged a draw, and classify them clearly. If battle numbers are the same in a round-robin tournament, the individual total sum of WP stands for the strength of the strategy. The simple winning grade SWG, which is calculated by dividing WP by 4 times the battle number, is the actual value in the interval [0,1]. SWG is a percentage of victory considering WP. If the result is composed only of complete win and complete loses, the SWG agrees with the normal victory percentage.

5.2 Necessity of rating index

In the preliminary league, the ranking may be influenced by a tendency of the main strategy group during a period. At the beginning of the period, very weak strategies by incomplete programs are included. A high winning degree by these does not show their exact strength. While a few aggressive students upload many similar strategies, the deviation of strategies causes inaccurate or unfair results with ill-suited battles. Thus, an affinity for the same type of strategy strongly appears. In some cases, it is possible to prepare a dumping strategy like kingmaker, and to raise the ranking of the strategy which wants to win. Therefore, it is necessary to reduce bias due to apparent strength and affinities. For this problem, a WP grade considering the strength of the opponent is necessary.

In games such as chess, the Elo rating is a famous player rating index. Elo rating assumes that the competence of each player is close to the normal distribution, and the change in ability is based on a logistic curve [20]. However, in this exercise, we would like to calculate the appropriate WP for each confirmed strategy. In reality, differences in programming skills are large, and extremely strong and weak strategies are mixed. In particular, the trends are remarkable at the beginning of the league. In addition, the rating is used as a ranking for the current record rather than for future prediction. For these reasons, we consider a rating index based on the standing at that time.

5.3 Improvement of weighted winning grade WWG

In this exercise, we introduce a weighted winning grade (WWG) as a rating index. WWG is a refinement index of SWG. It can make comparisons, even in situations with different number of battles in the middle of the preliminary league. WWG is the actual value on the interval [0, 1], and weights its own WP by the opponent’s WP. It is necessary to calculate recursively, because one’s own WWG changes with the change in the opponent WWG. When the number of battles is small in the early stage of the preliminary league, the definition of WWG prior to 2016 had a defect that caused a large fluctuation of WWG. For that reason, we adopt a new definition as of 2017 [21]. In addition, at a sufficient number of battles, the difference between the new and the old WWG is not noticeable except for in extreme battle results.

The fight number of strategy $x$ is $N(x)$ and winning points for strategy $x$ of $y$ is $WP(x, y)$; let $WWG_k(x)$ be the WWG for strategy $x$ by the $k$th calculation. The initial value is $WWG_0(x) = 1.0$. $WWG_{k+1}(x)$ is calculated by a recurrence formula. We repeat the calculation of the formula until the change in the value falls below an appropriate threshold. The value is the confirmed WWG.

$$WWG_{k+1}(x) = \frac{0.5 + \sum_{i \neq x} \left\{WWG_k(i) \times \frac{WP(x, i)}{4}\right\}}{\sum_i (WWG_k(i))}$$

In this definition, it includes a virtual battle with the same strategy. This definition accounts for draws by the +0.5 in the numerator. Here, the 1st calculation $WWG_1(x)$ is the simple winning grade $SWG(x)$, including self-draw.
The denominator is the sum of the WWGs, and it makes the WWG relative. If a strategy wins against all strategies, WWG does not result in 1.0 by self-draw. As the count of complete wins increases, it approaches 1.0 slowly. Furthermore, the WWG in complete loss to all strategies is not 0.0, but half of the reciprocal of the sum of WWGs of all strategies by self-draw. The as the number of battles increases, it slowly approaches 0.0.

The previous definition of WWG doesn’t include the self-battle in the numerator. In this way, if there is all-loss strategy, the weight of a win to the strategy is 0.0. Then, it spreads in the recurrence formula, and all WWG values converge to 0.0. In an early stage in 2016, the trend became noticeable, so we introduced the correction of the normalization. However, in contrast, if all the forces are in equilibrium and the victory or defeat becomes close to half, the WWG may be contrary to intuition. By the new definition of WWG, it can calculate a reasonable value in extreme situations of battle results. The convergence is also improved.

Table 4 shows winning or losing in 6 strategies of A to F, and the convergence condition of WWG. (a) shows the case when superiors always win completely to subordinates. A with all winning converges to 0.866, and F with all defeat converges to 0.183. Other strategies also converge to a reasonable value after about 6 iterations with oscillation. On the other hands, (b) is a slightly more complex winning and losing situation. A and B display 4 wins and 1 loss. However, A wins against B in addition to D, E, and F. B wins over C in addition. At that time, A wins against a stronger opponent than B, so A has a higher WWG than B. E and F each have 1 win and 4 losses. However, E wins only against D, and F wins only against E. E wins against a higher-rank strategy than F. Therefore, E’s WWG is higher than F’s. Both C in (a) and C in (b) have 3 wins and 2 losses, but the WWG of C in (b) is a little higher than C in (b) because of the win against the top strategy.

### 6 OUTLINE AND RESULT OF PRACTICES

#### 6.1 The outline of practices in our programming exercises

Table 5 shows a summary of the exercise practices from 2013 to 2016. The exercise period for this practice is ~5 weeks. In the first lesson, we introduce the rules of the game, and also explain strategy programming, local execution environment, and contest management server. The following week, the preliminary contest period begins. In class, we check the general ranking or submission state between other practices, and explain concepts further. The deadline is the end of the preliminary league. After that time, learners select their best strategy for the final league. In 2014, the server had failed. In 2015, the end time of other practices was postponed, so the start time of this practice was delayed. For this reason, we extended the practice period to avoid deadline conflicts with the other practice. However, the substantial development period is as usual. In 2016, the start of the contest was also delayed in relation to other practices. We
presented the development environment in the two weeks before the start of the contest, which is as short as the preliminary league. Therefore, we also provided a substitutional development period as usual. In an exercise in 2016, we had not adopted the thinning round-robin series, so the submitted strategy battles with all registered strategies were done at that time. It was not a problem until the middle of the contest period, by improvement of battle processing. However, in the end stage of the league, a delay occurred due to the increasing number of submissions.

### 6.2 The transition situation of submission

In 2016, the total number of submissions is 800. The average number of submissions per person is about 20. The maximum submission number is 67, which greatly exceeded 2015 numbers. Fig. 11 shows the transition of the number of submissions each year. The number in 2016 was similar to that in 2013. The plateau in the middle of contest period is less than in other years, and the number of submissions consistently increased. Fig. 12 shows a frequency distribution of the submissions. In 2013, there was a learner who submitted over 100 strategies. In 2016, the number of learners who submitted five or fewer decreased, and the distribution peak is on the right compared to the normal year. On the other hand, half of the learners submitted 20 or fewer. In the future, it is necessary to support these learners. Currently, we focus on the transition of results by a correlation of STG and WWG. It is necessary to find low-rank students based on submissions, students with less submissions, and low-rank students, and support or encourage them. On the other hand, we must also induce high-ranking students with fewer submissions to work continuously. If it is difficult to develop a new strategy, we attempt to induce learners to change their focus to the quality of their code.

### 6.3 Application of improved WWG to final leagues

We tentatively apply the new definition of WWG in Chapter 5 to the final leagues after 2013. Fig. 13 shows their correlation. The horizontal axis X is SWG, and the vertical axis Y is WWG. Spearman’s rank-order correlation $\rho$ is also mentioned in these figures. Each year, the correlation $\rho$ exceeds 0.99, and there is a strong correlation between WWG and SWG. Thus, it is considered to calculate ranking intuitively. Strategies with 0.4 to 0.7 SWG are differentiated by the strength of opponents. On the other hand, the number of strategies with lower differences is shrinking. This is because of the influence of self-battles.

### 6.4 Consideration

We consider changing regulations in the future exercise. First, considering the recent progress of game AI, we need to respond to strategies including random-number elements. In the case of strategies including random-number elements, the execution time becomes long. Therefore, we must consider the execution server load. In the evaluation method of the strategies, there is also room for consideration of whether a single match against the first or second player is good. It is also conceivable to combine point games, like the composed Go problem or Tsume-shogi. In addition, we also need to introduce some supports for students who don’t have good game records. Currently, for the purposes of discovering such students, we have proposed a transition graph (STG) and trace diagram TDQP, and are analyzing them [22][23]. STG is a combination plot of execution results and time courses (Fig. 14). TDQP visualizes the update status with the execution results and the absolute amount of code as two axes (Fig. 15). In the future, we will add some functions using these methods to enable the system to support them.

In the current exercise, students are allowed to submit only one strategy file as one class at a time. However, it is also possible to submit a strategy that defines multiple classes. In this case, we need to allow them to submit an archived JAR file. In addition, we may also need to correspond to strategies using external files such as a collection of standard theories. In such case, it may be possible to communicate with outside and acquire standard theories. In this regard, we need to consider this as regulation.

In the future, there is a high possibility of submitting strategies incorporating reinforcement learning in this exercise.
Furthermore, as an exercise for knowledge of information processing, it is possible to hold exercises on the theme of machine learning.

Table 5. Summary of practices in each year

<table>
<thead>
<tr>
<th>year</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period (week)</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Learners</td>
<td>37</td>
<td>35</td>
<td>44</td>
<td>40</td>
</tr>
<tr>
<td>WWG</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Thinning round-robin series</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>×</td>
</tr>
<tr>
<td>Total submissions</td>
<td>942</td>
<td>377</td>
<td>406</td>
<td>800</td>
</tr>
<tr>
<td>Average personal submissions</td>
<td>25.5</td>
<td>10.8</td>
<td>9.2</td>
<td>20.0</td>
</tr>
<tr>
<td>Maximum personal submissions</td>
<td>142</td>
<td>32</td>
<td>44</td>
<td>67</td>
</tr>
</tbody>
</table>

●: New introduction
○: Modified method
☐: Regular use
×: Unused

Figure 11. Ogive curves of submission number in each year

Figure 12. Frequency distribution of submissions

Figure 13. Application of improved WWG to final leagues in each year
7 Proposal of an execution environment framework

7.1 Execution requirements and characteristics about strategy programs

In this research, we consider external and internal evaluations for game strategy programs. External evaluation is mainly for obtaining calculation accuracy and processing speed as external performance. Regarding game strategy, it refers the score of execution results or the win or loss of the match, which expresses strength. Internal evaluation is the evaluation of code quality by software metrics (e.g., redundancy, efficiency, structuralization, and readability).

In addition, it is also important to grasp the progress of continuous program submission. We classify strategy programs into four groups from the viewpoint of execution performance.

(1) Both processing time and execution result are normal.
(2) Processing time is long, execution result is good.
(3) Execution result is remarkably bad.
(4) Processing time is too long.

Of these, (3) becomes noise for the records of other strategies. Therefore, in actual processing, there are no problems, even when deprioritizing the battle processing. (4) becomes a large cost by occupation of computational resources. They are necessary to eliminate as an error of execution time or excessive processing.

In addition, we also enumerate the functional requirements of contest management servers.

• Protecting non-public data in a server
• Responding to many executions and errors
• Ease of replication and change in execution resources
• Comparative verification of program operation and performance
• Estimation of operation and response to exceptional functions

Currently, based on these requirements, we have tried to realize the execution environment for each system. However, in processing by a single server, some problems occurred, such as occupation of the resource in protecting non-public data, and responding to any executions. It is necessary to solve these problems.

7.2 Present condition about distributed processing environments

Recently, distributed processing environments for high-load processing are improving. In the Apache Hadoop project, they have been developing and openly distributing some distributed processing libraries such as Map Reduce and Spark, distributed storage application HBase [24]. Amazon and Google provide managed services, such as Hadoop, on their own cloud environment [25][26]. However, the exercises in class have a greatly different load situation depending on time. Therefore, it can be said that efficient operation is difficult in an environment, assuming always...
operation. Adding a processing node at high load may be difficult for teachers. For these reasons, it is necessary to have an environment that easily handles high loads.

### 7.3 Execution environment using container environment

Therefore, we propose the environment “Cachalot” using a virtual environment that can execute programs independently, safely, and effectively. This is a sandbox for execution that aggregates execution environments prepared individually by each contest server. This environment is isolated from contest servers, so it is possible to protect non-public data. In addition, it is also possible to stop unusual execution from the outside.

Each contest management server can acquire the execution result by only sending an execution setting file (execution recipe) and the source code and so on to Cachalot (Fig. 16). In Cachalot, it prepares a container type virtual environment internally, and execute the code inside the container. As a result, independence and safety can be secured. It is also possible to safely stop unusual execution by transmitting an exit signal from outside. In addition, faster processing is realized by load distribution using multiple inexpensive computers.

Cachalot consists of 4 modules (Fig. 17). The contest server management module manages the contest server, which performs submission processing. It also manages images of execution environments related to each system. The execution container management module manages the execution time and resource information, such as assigned cores and assigned memory, and also inspects whether the execution condition is specified by the contest server. If a program executes for longer than the time limit, Cachalot kills the container safely. The processing nodes management module manages multiple nodes which process the execution container. The module also manages components such as the CPU cores and memory. The load balancer determines the destination of processing by the current state of the nodes.

### 7.4 Improvement of thinning round-robin series

We describe the improvement in execution of WinG-CS using Cachalot. First, we separate the regular battles, currently one stage into three phases (Fig. 18). After checking battle in acceptance processing, a strategy does a provisional battle. In the provisional battle, it joins about 10 prepared index strategies in a battle game. The WWG of index strategies is calculated as a criterion in advance. After finishing the provisional battle, the system calculates a temporary WWG of the strategy, and publishes the general ranking table as a flush report.

Next, during the submission suspension from 24:00 to 6:00, the system performs entry battles for all strategies submitted during the day. In the entry battle, a strategy competes about 100 strategies in a battle. At this time, the system equally chooses strategies from the WWG distribution. By this result, the system recalculates the WWG of all strategies, and publishes the general ranking table as daily result early in the morning. This is the initial WWG for strategies submitted the day before. At that time, Cachalot estimates the execution load by the execution time of provision battle, and reallocates resources.

After the next day, the strategies perform defensive battle as an opponent of other strategies in an entry battle. Strategies submitted in the early stages of the contest perform more defensive battles. The ordinary WWG of strategies change through these daily defensive battles.

### 7.5 Application to other systems

We describe the applications of Cachalot to other systems. First, each contest server receives a file from students. The server processes specific tasks for the exercise such as rewriting packages or renaming files as dependency injections. After processing, the server uploads the target file, necessary libraries, and execution recipe with setting into Cachalot. In Cachalot, resources are allocated in the processing node based on the execution recipe. This allocation is performed according to the load situation of the processing node. After the allocation, Cachalot starts the
execution in a container. After execution, Cachalot sends the execution result and information to the contest server, and destroys execution container. Cachalot also collects logs, such as execution time. In the future, we plan to realize load distribution based on the trends of each contest system.

8 CONCLUSIONS

We have practiced an applied Java programming exercise with a board game strategy. The exercise is in a contest style. Strategies are battled on a server, and their results and rankings are published. The students modify their code repeatedly using feedback during a contest period. We revise the contest management server to improve reliability and efficiency of battle processing. In particular, we adopted a virtual environment, and made the battle process efficient. We also revise the rating index WWG to refine the battle results. Furthermore, we reconsider the thinning round-robin series by the result in 2016. Thus, we arrange three stages of battle situations. In addition, we laid the foundations for distributed processing and the thinning round-robin series.

We propose the environment “Cachalot” for more effective distributed processing. Cachalot performs load distribution based on the statuses of the processing nodes. It also manages processing nodes with different performance. This realizes inexpensive, easy, and suitable load distribution for the educational site. In future work, we will try to improve the reliability and efficiency. First, we will implement functions for a revised thinning round-robin series to improve efficiency. Next, we will introduce code metrics as an internal evaluation to make students aware of not only the battle result but also the quality of code. This has learners promote continuous modification for refactoring. In addition, we will try to analyze learners’ actions during the contest.

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Figure 16. Overview of “Cachalot”

Figure 17. Architecture of “Cachalot”

Figure 18. Introduction of thinning round-robin
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The SDIWC *International Journal of E-Learning and Educational Technologies in the Digital Media* (IJEEETDM) aims to provide a forum for scientists, engineers, and practitioners to present their latest research results, ideas, developments and applications in the field of computer architectures, information technology, and mobile technologies. Original unpublished manuscripts are solicited in the following areas including but not limited to:

1. **Research papers:** that are presenting and discussing the latest, and the most profound research results in the scope of IJEETDM. Papers should describe new contributions in the scope of IJEETDM and support claims of novelty with citations to the relevant literature.

2. **Technical papers:** that are establishing meaningful forum between practitioners and researchers with useful solutions in various fields of digital security and forensics. It includes all kinds of practical applications, which covers principles, projects, missions, techniques, tools, methods, processes etc.

3. **Review papers:** that are critically analyzing past and current research trends in the field. Manuscripts submitted to IJEETDM should not be previously published or be under review by any other publication. Original unpublished manuscripts are solicited in the following areas including but not limited to:

- Intelligent Tutoring Systems
- Security Aspects
- Immersive Learning
- Computer-Aided Assessment
- Collaborative Learning
- Errors in E-Learning-Community Building
- Accessibility to Disabled Users
- Context Dependent Learning
- E-Learning Platforms, Portals
- Mobile Learning (M-Learning)
- Learning Organization
- Standards and Interoperability
- Virtual Labs and Virtual Classrooms
- Digital Libraries for E-Learning
- Joint Degrees
- Web-based Learning, Wikis and Blogs
- Authoring Tools and Content Development
- Synchronous and Asynchronous Learning
- Medical Applications
- E-Learning Hardware and Software
- AV-Communication and Multimedia
- Ontologies and Meta-Data Standards
- Simulated Communities and Online Mentoring
- E-Testing and New Test Theories
- Supervising and Managing Student Projects
- Distance Education
- Pedagogy Enhancement with E-Learning
- Metrics and Performance Measurement