Talent Targeting at secondary school – Pilot Study

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Abstract. All students have the right to an education that is appropriate to their ability, but this is not the case in practice, either at home or internationally. Generally, public education focuses on the middle of the Gaussian curve, and deviating from it in either direction is unfortunate, especially for students with a talent for computer science [1]. The current classroom evaluation and differentiation focus on student performance, ignoring the pupil's soft skills and personality, and it doesn't try to reveal the reason for underperformance, which also could come from hidden giftedness. The first step in providing the right level of education and talent management is to identify the students concerned. To support this aim, the article presents an approach used in business. This approach integrates personal traits, and soft skills into talent searching meanwhile continuously observe classroom works beside the results. The identification of the target group, its dynamic management, and the organization of the necessary measurements into a coherent concept form the theoretical background of an ongoing experiment. The subjects of Computer Science are important for every pupil regardless of their further education, as the digital culture covered science, business as well as everyday life. Talent searching and management of Computer Science at secondary school is particularly useful for pupils as well the community.

Keywords: Talent in informatics, formative assessment, algorithmic thinking, targeting

1. Introduction

The new national core curriculum in Hungary was presented in 2020, that place more emphasis on IT education [2]. The teaching of the digital culture subject provides greater attention to the use of IT in the learning of other subjects and in supporting different disciplines. This is strongly justified by the development and change in the digital world, as information technology evolved from a computing science - that is of interest and concern to a narrow group of students - to a cultural field covering all areas of life. As with mathematics, the auxiliary science character of computer science was confirmed which requires all citizens to be familiar with digital culture. This is more than digital literacy, the EU's European Digital Competence Framework for Citizens, updated every few years, or DigComp 2.2 for short, describes the content of the digital competencies currently considered relevant for EU citizens in the form of learning outcomes [3]. Following these recommendations, the national core curriculum has increased the number of lessons and, in addition to content search and management, which reinforces the nature of assistive science, also includes a stronger emphasis on algorithmic thinking and computer problem-solving.

In managing the increased number of lessons and the expanded curricula, students have more opportunities to demonstrate their potential in a particular area, while teachers have the chance to identify new students with potential in computer science. Not just for drive all students into IT careers, or to get more students into competitions, but to ensure that those with a good aptitude for IT develop it, whatever their career choice. In many areas of life, IT skills acquired in secondary school are an advantage [4]. There are many arguments for talent selection and talent management, one of which is a statement by Franz J. Mönks, a Dutch educator: *"Every effort should be made to ensure that every pupil, whether highly gifted or poor ability, can develop according to his or her abilities."* [1/p. 57.] In other words, every child has the right to an education appropriate to his or her abilities and interests, which, unfortunately, is not the case for all students, either in national or international practice. This is particularly true in the case of students who are gifted in computer science and who sometimes outperform their teachers in a particular area. The first step in providing the right level of education and talent management is to recognize and identify the students concerned. To support this aim, the article shows a complex approach used in business [5].

2. The burden of talent

The public perception is that talent is a blessing for both parent and child. But experience shows that in many cases it is more of a burden [1]. In line with societal expectations, public education is designed to fit the middle of the Gaussian curve, and deviations from the curve (whether negative or positive) are not adequately managed by the system [1]. In some countries, this approach to the educational system was amplified by history and the dominant ideology, like in Hungary. In the years of socialism, talent management was equated with an elite education and was neglected for a long time, and when its necessity was recognized again, it met with resistance from teachers [6]. In the 21st century, national education in Hungary is trying to catch up with international standards in an organized framework, with the support of the Federation of Hungarian Talent Organizations. At the same time, movements from the United States, which have emerged from the symbiosis of the academic and political left, are also placing greater emphasis on catching up underprivileged than on talent management. In Europe, this approach has always been stronger, so gifted students are still often left to their own devices, saying they can progress without help, they easily reach the level of skills and knowledge set out in the curriculum [7].

The literature on giftedness, however, reports experiences that differ significantly from the above, as confirmed by many parents and teachers who have encountered identified giftedness. Gifted students who are not taught at a level appropriate to their ability are usually under-performers, they can easily become unmotivated, lazy, and as a result, often become impertinent students with behavior problems that disrupt classroom work. It is in the interest of both the school and the teacher that gifted students do not disrupt the work in the classroom but is cooperative, while at the same time, these students should be given the opportunity to receive an education that is appropriate to their abilities and needs [1].

In the literature on giftedness, it is primarily the promises of giftedness that are of interest from an educational point of view [7]. Realized talent is seen in only adult life when the talent provides a sustained performance over a considerable period. Whether we talk about realized or promising talent, there are several models of talent, the common points of which can be summarized as follows:

- outstanding abilities (intelligence, creativity)
- good personality characteristics (motivation, perseverance)
- good environmental conditions

Of course, there are many different views on the details of each of these components in the known talent models. However, it is interesting to note that each of the common points is influenced by the public education system, the school, and the teachers who teach the students. Ideally, teachers have a key role to play in the development of skills, and in their education, they also develop the personality of the student, thus providing the right environment for the development and growth of gifted students.

It is generally believed that high intelligence - measured by several standardized intelligence tests - correlates well with talent. Interestingly, the seven main areas of talent were defined by the factor analysis of the questions in intelligence tests, which are the next: language, music, mathematical-logical, visual-spatial, physical-motor, interpersonal, and intrapersonal [7]. Information technology is not included, and it is difficult to establish a clear relationship between specific areas of information technology and the seven known talent areas from a digital competence perspective. Algorithmic thinking and systemic thinking can be assumed to be underpinned by good mathematical reasoning skills, while creative skills benefit from an advanced level of visual and

spatial perception. For many students, the use of ICT tools and applications relies on a fully automatic, bodily-motor ability, while the competence to search for and manage information relies as much on linguistic skills as on mathematical-logical skills.

Gardner identified the seven talent areas in the 1980s when computer science was just infiltrating secondary schools with the first personal computers [7]. There was no subject in which computer science education was organized, so standardized tests did not include questions to test competencies in computational thinking. It would be useful to develop newer intelligence tests that would now include components of digital competencies, following the changes in curriculum and syllabus over the last 40 years.

Abraham Maslow's work is well-known in economics, he studied people's motivation. In his view, people's actions, the motivation behind their actions, are determined by their needs. He set up a hierarchy of needs, at the bottom of which, as the most basic human need, is the satisfaction of physical, and physiological needs (food, drink, clothing, shelter, etc.), followed by the need for security, then the belonging and after it the self-esteem, recognition. When these are fulfilled, one can move on to the higher needs of understanding the world, aesthetics, and harmony level, and finally, at the highest level, self-actualization [8]. Maslow's hierarchy of needs has not been validated and is disputed by many because of the methodology used. Maslow involved specifically successful, talented people in his research, so he looked at presumably motivated people. This warns that it is not only successful people who should be interviewed [9]. In business, it is possible to focus only on success, but in education, it is important to analyze failure and its causes in order to reduce the rate of failure.

3. Giftedness in information technology

Since the talent models and available talent tests do not focus on IT talent promises, an important question is: who can be considered talented in IT? Someone who has been programming since kindergarten. If such a child exists, he or she is probably gifted, but more general, measurable criteria are needed. There are, of course, professional recommendations on what skills and abilities should be present at a given age. For those students who are 2-3 years ahead of their age group, there is a presumption of potential talent [1][7]. In addition to the literature on giftedness, several studies [1][10] have demonstrated that children, following the parental model, can have additional knowledge in the area of competencies related to the activities their parents practice from an early age. In the case of IT, more and more parents are nowadays using computers in the home, so children following this model can also learn about computers as soon as possible. The motivation to learn about computers is reinforced by the entertainment content, games, and videos on computers, which now offer greater freedom of choice and interactivity than television. However, it is questionable whether watching videos and playing games is an indication of potential IT talent or it displays merely a motor fixation on the steps needed for entertainment. It should be noted, however, that for many children, computer entertainment is a motivation to learn computer use and other related skills and may therefore be a gateway to a community of IT talent.

In the literature, there are many approaches to searching for and identifying IT talent and talent promise, as to what students should know and in what areas they should excel. Ionica-Ona describes technological talent as *"the expression of the superior endowment in different areas of the technical field, as the excellence, demonstrated by an outstanding performance in this field or as a potential of excellence demonstrated by the results in various forms of evaluation."* [11/p. 2.] Another approach is the EU's definition of digital competence, which provides a hierarchical set of skills and competencies [3],

including application skills, and algorithmic thinking for programming [12][13]. Computational thinking is also widely used in the international literature, but it is as difficult to define as talent, as it is one of the youngest disciplines and fields of knowledge and is developing very rapidly [14]. However, the main components of computational thinking, such as decomposition, pattern recognition, abstraction, generalization, and algorithmic thinking, and those components can be highlighted as they are measured by tests.

Thus, to identify IT talent, we cannot use a single well-established test, but by using tests from multiple approaches, we can gain insight into the knowledge and competencies of individual students in the given area of IT.

4. Digital culture education

The NAT2020 curriculum currently in force in Hungary, considering the EU key competencies, recommends the use of IT tools in almost all subjects in order to help students reach the appropriate level of digital competence [2]. Mathematics subject requires the use of computer games and programs to develop mathematical skills by the end of grades 1 to 4 in addition to solving mathematical problems by computer. The use of games to develop mathematical skills is a curricular requirement even for the next age group of 10-14 years. The digital culture subject starts in grade 3 when the primary aim is to develop an appropriate attitude to the use of tools, supported by creative work and the use of drawing programs. In addition, they are introduced to the basics of coding through the control of age-appropriate robotic devices. In the upper grades, the aim is to learn how to use common office applications and learn the process of algorithmization through robot programming. Students entering secondary school will thus already have measurable knowledge in the main areas defined by the EU Digital Key Competences.

As many students have learned about computer science through games, many of them have become enthusiastic and motivated to learn IT, and this momentum should be used in education. On the other hand, some students have lost their motivation or never had it. As the new digital culture subject proposes the use of IT tools to support the teaching and learning of other subjects, this can help to develop motivation and interest in IT for students, who are engaged in other subjects.

In the classroom, of course, the aim should be to ensure that as many students as possible are active participants in the lesson. The teacher must give pupils tasks that match their interests and abilities and are able to arouse their curiosity. In task-solving activities, the teacher has the opportunity to observe the problem-solving skills and abilities of individual students, and through these gain insights into their thinking. Students who are either faster than average or who have more unique and interesting solutions than the others should be invited to a specialization, which gives the teacher more opportunity to identify potential talents and nurture them.

5. Statistical approach

There are known and lesser-known difficulties in talent identification, some of which are highlighted here [1][7]:

- Existing talent tests can help identify gifted students, but a test, or even a series of tests, may not be sufficient to identify a gifted student.

- Psychological tests can also help to identify gifted students, but, like talent tests, they investigate pupils' endowment only once, on a given occasion.
- Teachers can observe their students on a continuous basis, but in most cases, they have to give students tasks that students of average ability can do, again reducing the chances of identifying students of outstanding ability.
- The special classes offer a good opportunity, but students apply for these on the basis of interest and motivation, which again reduces the possibility of identifying potential talents, as students with insufficient self-awareness and self-confidence usually don't join these courses.

Based on the back-track algorithm, leaving aside the difficulties, let's step back and look for another possible path. Let's start with an estimation, an approximation, of how many students in a secondary school can be gifted. The gifted pupils should not be confused with pupils, who get straight excellent marks. It is well known that there is considerable variation across secondary schools, with most secondary schools seeking to recruit the best-ability students and create homogeneous classes in terms of ability [15]. Despite the homogeneous classes, there are differences among pupils' abilities based on the Gaussian distribution regardless of their marks and test results [15]. Exploring these differences and to understand the reasons behind them is part of the talent search task, as it helps to find more and more potential talents.

The various talent models give approximate estimates for their models of what percentage of a given age group might be talented according to the model. Given that different models created by different experts used different definitions of giftedness and different characteristics, it is not surprising that the proportion of students in the age group who were assumed to be gifted was estimated differently. Terman (1925), who used intelligence tests to measure talent, estimated that the top 1% of the population might be gifted; Robinson (2005) estimated the top 1-3%; Brody and Stanley (2005) estimated the top 3%. Freeman (2005) sees the top 5-10%; Gagnè (2005) the top 10%; Gordon and Brigdlall (2005) see the top 15% of the population as gifted; finally, Renzulli (2005) sees the top 15-20% of the population as gifted. Terman's and Robinson's models are more specific, while Renzulli has a more general model. As we focus on searching for potential talents, it seems better to select the widest range, 15-20% of students rather than the 1% [7].

Economics also can help to choose the right ratio, as there is a rule of thumb, which was created by Vilfredo Pareto in 1906. Based on his observations of the unequal distribution of wealth, he created the 80-20 rule, whereby 80% of the wealth produced goes to 20% of society. Joseph Juran (1940) made a similar observation in the field of quality when he recognized that 80% of problems are caused by 20% of the mistakes made [16]. Later, the Pareto principle became general in economics and management science, and it is commonly called the 80-20 rule. As is a rule of thumb, important to note that the exact rates are different, that only approach the 80-20 values. The most well-known statement is 80% of the turnover is generated by 20% of the customers, and 20% of the sales generate 80% of the turnover [17]. Nowadays Pareto-principle is also used in Computer Science as well as education [18].

The common application of the Renzulli Talent Model and the Pareto Principle is worth considering 20% of students as potential talent. On one hand, Renzulli's model contains the widest range among the well-known talent models, which means he supposed the most potential giftedness within an age group. On the other hand, based on the general meaning of the Pareto principle can be supposed the best abilities characterize the 20% of pupils in an average class. Which students should be included in the 20% and which in the 80%, and how final these choices are, is also a question that is worth following a method used in economics.

6. Application of targeting at the secondary school

In the business world, marketing is about identifying and engaging potential customers who are the target audience. Targeting is the process that defines the target group. An important aspect of targeting is the application of the Pareto principle. The primary task is to find the 20% of customers who generate 80% of the turnover. In the business world, this is easy to determine from sales data in most areas. In addition to the current and previous traffic data, it is useful to know the potential of the target group, and whether the known traffic can be further increased. On the basis of this information, businesses can modify their marketing activities and messages, increase or modify their resources, or even target other customers.

Differentiation is used in education for similar purposes. Keeping students of different abilities and interests motivated and stimulated requires different tasks. In most cases, differentiation is based on the teacher's observations of the lesson and the results of students. For a more effective application of differentiation, targeting, which is used in business, can provide useful information, as it focuses on opportunities and customer potential. By considering the similarities and differences between business and education, a model can be developed to test the use of targeting in education.

Talent potential is the promise of an individual student's talents, and it is generally an unknown variable in public education. Student performance, which can be compared to business turnover, fluctuates. For more accurate modeling, we can choose a narrower slice of the business world, where, as in the school environment, there is also limited information available. One such business is the pharmaceutical industry where, due to the specificities of the market, strict regulation protects the real potential of the doctors who generate the turnover and are therefore the target group. Prescription medicines cannot be freely advertised in most countries, and pharmacy turnover data are only available at the sub-regional, district (brick) level, so neither the specific number of patients nor the number of prescriptions is available at the doctor level. Representatives of pharmaceutical companies, therefore, must estimate the potential of prescribing doctors indirectly. Sales representatives are responsible for getting to know the doctors practicing in their territory through regular visits, in the same way, that teachers get to know the skills and qualities of the students they are responsible for during classroom activities [19].

Targeting can be done on the basis of two main categories, and within each category, several criteria can be applied. These two main categories are potential and loyalty (or engagement), both of which can be identified and applied in secondary school talent management.

6.1. The potential

The concept of potential, in our case talent promise, is challenging to define, but the various talent models describe it well. In simple terms, we consider gifted those students who can perform at well above-average levels in an area of ability. In order to identify giftedness, we need measurements and an analysis of the measurement results. It is important to emphasize the plural, as many promising talents will block and underperform under the pressure of the all-important, unrepeatable assessment [20]. On the other hand, we do not have a test that will prove talent beyond all doubt. Similar to the pharmaceutical industry, approached from several angles, the aggregated results of different measures and approaches help to give a good estimate of the potential either of a given doctor or a given pupil. The next couple of assessments provides an extendable, customizable system to assist potential calculation.

One important area to measure is digital competencies. When measuring, it is important to use formative assessment, even monthly or biweekly frequencies. Many students experience testing as a stressful situation and underperform, especially in the case of summative assessment [20]. To reinforce the formative character, it is advisable to have students write playful tasks and tests of a quiz nature. Kahoot is a well-known and popular environment [21][22], and interesting and playful exercises can be found on the e-Hod (Bebras) [23] and CS-Unplugged websites [24]. In the tests, care should be taken to ensure that there are also simple tasks that all students can do so that they do not become demotivated by the potential failure. At the same time, more difficult tasks should be included in these tests, which require the outstanding ability to solve correctly. Such tasks can be found in the archives of the OKTV competitions [25] or on the websites of international competitions. The results of these tests can be quantified and summarized.

In addition to measuring competencies frequently, it may also be useful to measure other abilities occasionally. For example, completing a general intelligence test helps with talent selection. A high quotient on a general intelligence test is often an indication of outstanding ability or talent in several areas [6][7]. Of course, this does not automatically indicate IT talent, but it can be a useful component of potential. During digital culture lessons in a classroom equipped with computers, it is possible to have students complete an online intelligence test.

Talent models attribute an important role to creativity in addition to intelligence. Creativity is also difficult to measure, but there are some available online tests to assess it. On the other hand, programming problems are characterized by the existence of several good solutions. Thus, the better way of measuring creativity is to discuss the possible implementations of problems in digital culture lessons, and select pupils who have unique, creative ideas during this discussion.

The results of the creativity and intelligence measures can also be quantified so that these results can be added to the scores, and results of digital competence. While subject knowledge and competencies can be measured on a weekly basis, general intelligence and creativity are enough to measure once a year. Of course, these abilities also change over the course of secondary schooling, but for the purposes of measuring talent, these changes are generally not significant, with only small differences between the values measured at different points in time.

6.2 The engagement

The other dimension of targeting is based on loyalty and engagement. Loyalty means customer loyalty, which is a useful indicator in business, while engagement is more applicable instead of loyalty or loyal to IT at Secondary school. Even if a talent is recognized and identified, the student may not be interested in the subject and may not want to engage with it. A typical case is when a student has a talent in mathematics in addition to computer science and prefers to focus on mathematics. Many students learn English through the use of computers and computer games, and there may be some who still see IT as only a useful tool and commit themselves learn English. The students' environment can also influence their engagement, whether it is peer groups, parents, or another teacher who pushes the student in a different direction. Commitment can be reduced by the lack of confirmation and confidence or personality traits such as laziness. Thus, as well as the potential that promises talent, it is important to pay attention to the level of engagement, the extent of it, and the reasons for it. Similar to the system of potential tests the next assessments help to measure, to approximate the engagement and these also form a system.

The level of engagement is boosted by positive reinforcement, good results in competitions, and a supportive atmosphere. These influence and interact with student motivation. Maslow's pyramid

of needs can be used to test this. For instance, students in families with many children, even if they have good financial resources, are more motivated by goods, while others are motivated by recognition, respect, and kudos.

Defining the extent of engagement is more difficult, as it is complicated to measure at all, and has qualitative rather than quantitative components. Most can be based on teacher observation, but there are known, well-defined qualitative characteristics that are measurable and their results can provide data on the degree of engagement or the difficulty of recognition.

In addition to the various skills, the study of interpersonal and social skills, in other words, soft skills, is becoming increasingly common. In secondary school, communication skills, the ability to cooperate, and to participate actively in teamwork are of particular importance. These interpersonal skills are both measurable and easy to observe in class. In contrast to ability, it is often the underachieving students who need attention as potential talent prospects in the case of interpersonal skills [26]. This is particularly the case for IT talents.

It is also worth asking students to complete a simpler test measuring general personality traits. One example is the DISC assessment developed by William Marston, which is widely used in both business and human resource management. This test, in addition to the extrovert or introvert, task or relationship-oriented personality type, also helps students to identify their motivation and the communication style they need [27]. Since these personality traits are largely established by the end of secondary school, it may be sufficient to have students complete this test once during their secondary school studies.

Formative assessment is not only useful for measuring and giving feedback on subject knowledge but also for other competencies needed to learn and apply a subject. A SWOT analysis, similar to the SWOT analysis used in business, can be carried out with secondary school students. It assesses the strengths and weaknesses of a particular student and those opportunities and threats, that come from the pupil's environment. Using a predefined set of criteria students should be asked to decide whether the area is a strength or weakness in terms of internal factors or an opportunity or threat in terms of external factors. For internal factors, the analysis examines competencies, including skills such as independent learning and the ability to manage time. External factors analyze the effects of the environment, like family, school, classmates, friends, etc. One of the benefits of these analyses is that they remind and inform students of the competencies they need and the environmental features that affect their lives and studies. Internal factors can be gradually improved as a result of the learning process. The external factors, although not influenced by students, they can prepare to counteract those by recognizing the risks. Such a guided SWOT analysis is also recommended to complete with students every six months [28].

The DISC personality test, for example, helps to identify the backgrounds of motivation of a person, which can be used to identify whether the student is really unengaged, unmotivated, or simply introverted and unable to express his or her interests. The external factors of the SWOT analysis also help to build a picture of the student's motivation and commitment based on what factors he or she assesses as opportunities and what as threats. For those who see extra-curricular activities and competitions as opportunities and computer and video games as threats, engagement can be assumed. Both assessments help to reveal if there is potential talent behind the observed underperformance. Using this information in conjunction with classroom observation, the engagement of individual students can be well defined.

As with potential, it would also be useful to quantify commitment, but the above criteria only allow for this to a limited extent. However, they provide sufficient data for a three-level assessment, like committed or positive, undefined or neutral, and dismissive or negative.

6.3. Classification

In the business world, the last step of targeting is the segmentation of customers. In many cases, the classification and categorization of customers are based on a single criterion, the potential. Customers with a high turnover are important, and those with a low turnover are less important or even irrelevant. It is important to note here a fundamental difference between business and education, in the latter case all students matter, and classification provides useful information for classroom differentiation. In the pharmaceutical industry, which is used as a model, the potential-based approach is also typical, but increasingly a two-level, two-criteria segmentation is being used, where commitment and loyalty are examined alongside potential. The two categories are two axes, two dimensions of a Cartesian coordinate system. The horizontal axis is used to denote potency and the vertical axis is used to denote loyalty, with only the first quarter of the coordinate system being used. Also, in the case of two-dimensional classification, the first step is to classify prescribing physicians, who thus generate traffic, on the basis of their potential.

In school usage, based on the calculation of the potential presented earlier, students achieve different overall scores after summing up the results of different tests and assessments. Recommended the usage of the relative values, the calculated percentage from their scores. For each group of students, there will be a minimum and a maximum value, and the scores of each student will be distributed between these values. In a similar way to the norm-oriented assessment often used in public education, some point boundaries between the minimum and maximum values should be assigned. The common practice in the business world is to define three or four segments by setting two or three cut-off points. To distinguish between them, the letters of the alphabet are used, so that students in a class can be grouped into A, B, and C, or A, B, C, and D. The number of categories also depends on the number and homogeneity of the groups of pupils. For small or homogeneous groups, three groups are sufficient, for larger or very inhomogeneous groups, four groups may be used.

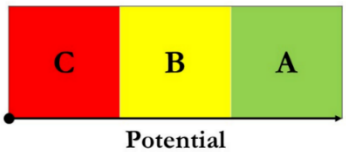

Figure 1: Segments by potential

Unlike the norm-oriented assessment, the point thresholds should not be set in relation to the average or other reference value but should take into account the number of groups. In the first group, the students with the highest scores, who are considered to have a strong promise of talent, are placed in this range, which, as described in Chapter 5, is about 20-25% of the students. This can be increased for small groups, can be selected by three students from a group of 10 students, or even four if there is a point identity. The middle range should be the widest, which includes about 50% of the students. The remaining students with lower scores are placed in the third group, in almost the same proportion as the first group, following the proportions known from the Gaussian distribution.

The second aspect, the inclusion of engagement in the segmentation, refines the potential-based classification. In business, a two-dimensional classification indicates more sophisticated planning and a more serious strategy. In a school context, it is almost essential to take into account the motivation and diligence of students. In business, too, the use of potential-based classification, often calculated on the basis of performance alone, narrows the target group and does not rely on the skills of the salespeople. This may bring the expected turnover in the short term, but in the

long term, it can result in a competitive disadvantage. In public education, it also narrows the target group by excluding students who have the promise of talent, but it is required more and more sophisticated work to reveal it. Personality traits and interpersonal skills are difficult to quantify, as students are assessed according to a number of different criteria and carry qualitative rather than quantitative information. However, it is important to use them to compensate for the potential calculated by competency tests, where this is justified. This, of course, requires more attention and more professional knowledge and work on the part of the teacher.

Based on the 3-degree scale proposed for engagement, 3 well-defined groups emerge. Thus, when combined with the 3 groups formed by the potential, students can be classified into a total of 9 groups. The second dimension aims to make the boundaries of the existing 3 groups more flexible and more easily crossable. One of the main drivers of the learning process is motivation, which is an important part of engagement. A lower-scoring but motivated student can often be engaged in more challenging tasks than a higher-ability but less motivated student. It is for this reason that the two criteria classification places students with lower scores but motivated by the potential in the higher segment.

The introduction of a second dimension may of course change the boundaries defined on the basis of potential. The boundaries are flexible, so in such cases, it is advisable to modify the boundaries, so that the proportion of students in groups A, B, and C is as close as possible to the 25-50-25 percent distribution.

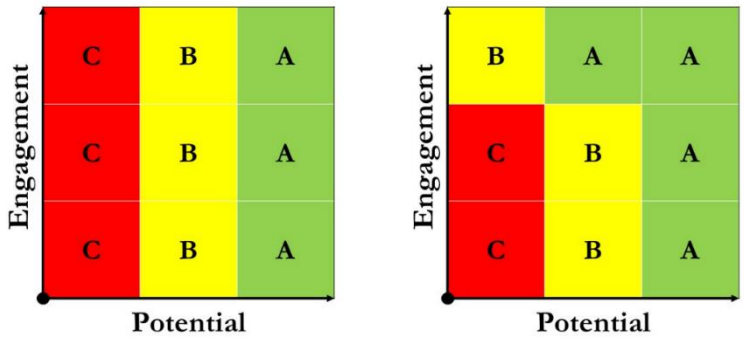

Figure 2: Two-dimensional segmentation and the corrected one

The assessments are continuous during the academic year, and the overall scores will change accordingly, with students in the third group can be moved to the first group and vice versa. Students placed in the middle group may move up or, in the absence of this, into the third group as a result of educational activity in the school and individual learning, interest, and motivation when the new classification is made.

The purpose of the classification, and the grouping into different segments, is to ensure that students receive the appropriate tasks and education in the classroom according to the measurements and the activity. On the one hand, this helps the teacher's work, provides a framework for differentiation in the classroom, and on the other hand, it is also useful for the students, because they can be given tasks that are challenging according to their abilities, and their interest, but not impossible, and provide the opportunity for a sense of achievement, which is essential for a successful learning process. While the commonly used classroom differentiation focuses on only the potential this kind of classification also takes into soft skills, and personal traits as well as the intent of further study.

6.4. Timing

In the business sector, companies operate sales cycles linked to calendar periods. Quarterly sales cycles are common, but there are also trimester, six-month, and annual cycles. Depending on the company's strategy, the current ratings need to be reviewed generally every sales cycle, but at least once a year. In public education, the half-yearly cycle is typical, so it is sufficient to review the classifications every six months and to reassess each group of pupils. The level of potential and engagement is constantly changing as the results of formative assessments or possible competitions are entered into the teacher's spreadsheet. Engagement may also change, this is typically less frequent. The scores over the course of the semester, together with any changes in attitude the teacher records. This information is tracked and monitored by most teachers anyway, so it does not represent an additional burden for the teacher. And the evaluation of the data collected is only an additional task every six months, which usually takes less than an hour using the method described above.

7. Pilot targeting at secondary school

The group of students selected for testing is a grade 11 computer science special class at a secondary school in Budapest with a total of 22 students. In the previous grades, they had been taught computer science by other teachers, so we started working together without any prior knowledge of the students.

After an introduction, in which their future goals were covered, the students completed a DISC test. This provided a baseline for the teacher to get to know the students' main traits and behavioral motivations [27].

The first test to assess the student's previous studies was a playful quiz in Kahoot, which did not require any specific programming knowledge. It is a diagnostic assessment, that helps determine the potential of students. At the beginning of the semester, there is no pressure on students to achieve a better grade, the quiz format motivates students to achieve a better ranking so that students experience the assessment as a game. Regular assessment in a quiz environment is perceived by students as a regular game, which they often experience as the highlight of the lesson. During the first two months of the semester, pupils completed tests on the following topics in a Kahoot environment:

- how computers work, Neumann principle
- algebraic operations and logical expressions
- using the numeral systems (focus on binary)
- search and sort algorithms

The first major contest was the Bebras competition, which we entered together in the second week of November. The results of the Kahoot test and Bebras competition are now sufficient to produce the first classification. First, a potential-based classification was made based on the aggregated scores of the competency tests.

However, the aggregate assessment should take into account possible bias factors. In particular, in the case of regular assessments, it cannot be guaranteed that all students attend all lessons, so any absence must be taken into account. Different scores are achievable on different tests, so the results are not so comparable, the sum may cause disproportionality. It is therefore advisable to use relative values, the average of the percentages achieved in each test, rather than the sum of scores. There

may also be differences in the difficulty levels of tests, so the more difficult tests can be given greater weight. In the present study, the scores of the Bebras competition have been weighted twice and the tests that were not written have been excluded from the calculation in order not to unduly reduce the average of absent pupils.

The table includes the initials of the students, the results of the first diagnostic assessment, the additional Kahoot tests, and the results of the Bebras competition. The results of the 5 tests taken in 10 weeks already provide a good basis for measuring continuous performance, which is necessary to calculate the potential. With 22 students, the inclusion of 4-6 students in category A is justified according to the Pareto principle. In the results of the given tests, it is observed that there is a larger point difference between students 4 and 5 than between students 5 and 6. In the lower range of scores, there is a larger difference between 5th and 6th, but there is also a separation between 4th and 5th. A potential-based ranking can best thus be constructed in a 4 - 13 - 5 split, which can be further refined by including engagement.

Pupil	CT	AT	NS	SA	BS	Avg
HA	53%	100%	89%	87%	87%	84%
BD		85%		80%	82%	82%
ZA	63%	85%	0%	60%	98%	81%
KM			68%	93%	69%	80%
CM	58%	96%	79%		77%	77%
KD	48%	81%	58%	93%	93%	77%
VA	50%	100%	79%	67%	77%	75%
PM	48%	88%	95%	67%	71%	73%
GD	53%	96%	79%	67%	71%	73%
TB	50%	73%	79%	73%	71%	70%
GH	30%	96%	79%	73%	66%	68%
IB	58%	81%	84%	67%	55%	67%
PD	50%		68%	53%	81%	67%
LD	53%	69%	63%		74%	67%
CG	45%	92%	68%	73%	53%	64%
RA	65%		47%	87%	55%	62%
HR	55%	85%	68%	60%	50%	61%
DZ	48%	96%	53%	67%	47%	60%
BJ	40%	58%		67%	61%	57%
PS	45%	88%	74%	53%	31%	54%
PB	50%	73%		40%	49%	52%
MP	58%	62%	32%	40%	47%	47%

Table 1: Potential-based classification of pupils

The activity of students in class is good, despite the higher headcounts in this group, which is unusual for IT lessons. The monitoring and tracking of classroom work and student motivation is an important teacher task. So, it is also advisable to record the activity observed in each lesson with at least a small plus sign or a minus sign, or possibly a zero to indicate neutrality. This helps to

ensure objectivity, which is very difficult to achieve in the case of such qualitative traits. In general, students with the highest scores on the scoresheet on which the potential-based grading is based are also spectacularly active in lessons. However, after two months, 7 students were still at 0 points because they had not shown any measurable classroom activity. Their better understanding and more objective assessment are important, and the results of the tests help with it.

According to the DISC personality test, half of the group members have introverted personalities, their motivations are not so visible, and expect to be spoken to and asked questions by the teacher. Those passive pupils, who are introverted by DISC assessment, got an extra point as a correction score in their loyalty. Extroverted pupils are proactive and often speak their minds without being prompted. Some of them were passive, sometimes a little hostile in class they got 0 points for their engagement. Those students, who like to study IT and who are successful in computer science, generally have S and C DISC traits. This is also observed in this given math and computer science special class group of students. There is only one student whose DISC test revealed neither the S nor the C trait to be dominant in their behavioral characteristics.

As part of the formative assessment, at the end of October, students completed a SWOT analysis of their own using the template prepared [28]. On one hand, it develops students' self-assessment skills and on the other hand, it gains a deeper understanding of the qualitative characteristics of engagement. Based on the external factors of the SWOT test, additional students were awarded an extra point, who felt that the competitions and the afternoon sessions offer a good opportunity for their development. This guided SWOT test sent important feedback to the teacher, pointing out that the skills of co-curricular work and cooperation are weak within the group, and pupils need organized group work in lessons.

Using the DISC and SWOT analysis, 3 of the 7 students with previously unassessed activity remained in the passive, unmotivated category. Three students got one point, so their engagement achieved a normal level, while one student got a correction factor based on both tests and was placed in the engaged student category. Finally, the potential-based classification can be refined by the engagement values. Starting point is the 3 ranges of potential calculated based on the point counts. As the collected table of engagement also contains three values, the two-dimensional classification can be illustrated with a 3x3 table. The first step is to extend the table to the second dimension independently of engagement values, and then the highly engaged students in the top row of the table are moved up one category on the previously developed potential scale, where reasoned. Finally, using the two-dimensional segmentation, the classification shown in Table 2 was obtained after the corrections were made. Four students were placed in a higher category based on their engagement, three of them in the A segment. Based on their test results they were not potential IT talents however, they got more attention, a better chance via this segmentation.

After the modification, if the bounds for the potential are left unchanged, the distribution of pupils is 7 - 12 - 3, which is disproportionate and far from our theoretical rate. The important aim of teaching is to support and develop pupils, so this deviation is useful from a didactic point of view. However, at the bottom of the table, easier tasks may motivate weaker students more, so the boundary of category B was upper a little. It improved the ratio of distribution, the number of pupils is 7 - 11 - 4 by segment.

Analyzing the table, we observe an interesting and challenging student for teachers, identified by the initials KM. The student scores well on various tests, but his engagement is missing, and his class work, or lack of it, is not explained by the personality tests he has taken. In his case, a personal interview was required to discuss his future and interests, so that he can be involved in more active class work with appropriate tasks and to develop his good IT skills. He explained that he would

like to study movie directing which is far from IT in his point of view, in the first discussion. This was followed by further discussions on a weekly basis. We analyzed together movies from an IT aspect, which highlighted a lot of misunderstandings. The breakthrough was achieved by a personal story about a former pupil, who disliked IT, but he learned it. Especially multi-media applications as he was interested in those. After secondary school, he couldn't find his place, he was not admitted to the university. He tried to get an assistant position on movie projects when a director asked him, if could he handle the Final Cut application. It was his entry into the world of movies, and his greatest success was his participation in the Oscar Gala where a film won the award in the short film category that was cut by him [29]. It has changed his motivation and his engagement. His customized tasks mostly refer to movies and the process of movie-factory to stay his interest.

Pupil	CT	AT	NS	SA	BS	Avg	Engagement
HA	53%	100%	89%	87%	87%	84%	2
BD		85%		80%	82%	82%	1
ZA	63%	85%	0%	60%	98%	81%	2
KM			68%	93%	69%	80%	0
CM	58%	96%	79%		77%	77%	2 ▲
KD	48%	81%	58%	93%	93%	77%	1
VA	50%	100%	79%	67%	77%	75%	2 ▲
PM	48%	88%	95%	67%	71%	73%	2 ▲
GD	53%	96%	79%	67%	71%	73%	1
TB	50%	73%	79%	73%	71%	70%	1
GH	30%	96%	79%	73%	66%	68%	
IB	58%	81%	84%	67%	55%	67%	1
PD	50%		68%	53%	81%	67%	1
LD	53%	69%	63%		74%	67%	0
CG	45%	92%	68%	73%	53%	64%	1
RA	65%		47%	87%	55%	62%	1
HR	55%	85%	68%	60%	50%	61%	1
DZ	48%	96%	53%	67%	47%	60%	1
BJ	40%	58%		67%	61%	57%	1
PS	45%	88%	74%	53%	31%	54%	1
PB	50%	73%		40%	49%	52%	2 ▲
MP	58%	62%	32%	40%	47%	47%	1

Table 2: Two-dimensional classification of pupils

This kind of teacher activity is also well-known activity of talent management it is called mentoring [30]. The best case is school provides a full-time mentor for mentoring gifted students. Unfortunately, most school has not the possibility to employ a full-time mentor, so the mentoring depends on teachers' engagement. However, engaged teachers can get professional support from national talent organizations.

To summarize, the task assignment in 3 categories changed the classroom work. The activity was increased in each group. In addition to individual tasks 2-3 members groups were organized to practice group work and cooperation. The results of the formative Kahoot test are also improved week by week. Pupils are motivated by their customized tasks, that are suitable for their abilities. The motivated learning environment provides continuous development and gains for pupils.

8. Conclusion

Targeting and target group segmentation is primarily complementary tool to support educational activity, classroom differentiation, and talent management. It is not a fully personalized method, but it helps teachers to provide more customized tasks and activities for pupils based on their abilities. Continuous assessment as a regular formative assessment gives not only students but also teachers very useful feedback on students' progress, and about topics that are difficult to learn and understand. For A students, it is advisable to use the acceleration and enrichment method, which is also used in the IT and digital culture subjects and is widespread in gifted education [31].

The three groups of pupils are still manageable as a classroom differentiation, meanwhile it provides customized tasks for each group. The segmentation creates competition between pupils. The teacher must observe if this blocks a student, it should be managed with personal mentoring. Generally, segmentation and targeting have more benefits than disadvantages. While the difficult tasks demotivate weaker pupils, while the too-easy tasks are boring for gifted students. Segmentation-based differentiation provides a usable solution as it evaluated whole pupils instead of only their results. The weaker pupils get suitable tasks as well as the gifted, so the more active classroom work provides development for each pupil and helps to gain engagement for IT. The wider classroom work gives a possibility to recognize more talented students in IT. Engagement in IT does not mean that every pupil must study IT at university. IT covers every area of life and science, so the pupils can use their well-developed IT knowledge everywhere. The high-level IT knowledge from secondary school provides a competitive edge for pupils in most areas of life [4].

Talent development and identification also require practice, solving problems of varying difficulty, both individually and in groups, for example in project work. It is important, however, that students experience success in solving their tasks, which require differentiated classroom work with tailor-made or at least group-customized tasks. This is supported by this presented targeting and grading adapted from the business world. The proving requires wider research on bigger samples.

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